AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

SEPTEMBER, 1897.

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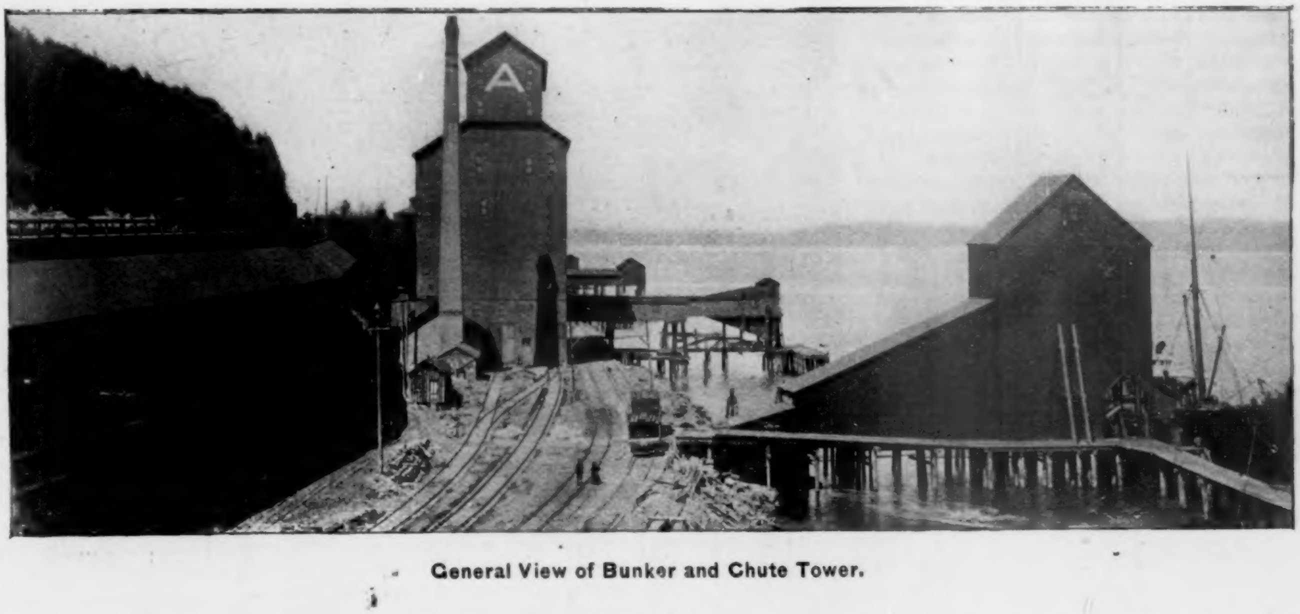
Coal Bunker at Tacoma—Northern Pacific Railway.

The new coal bunkers built by the Northern Pacific Railway at Tacoma, Washington, for the purpose of loading vessels at that port, combine large storage capacity with economy in handling coal and low construction cost for the plant. We acknowledge the courtesy of Mr. E. H. McHenry, Chief Engineer, and Mr. Charles S. Bihler, Division Engineer of the Northern Pacific Railway, for the drawings, photographs and information which form the basis of this description.

Coal bunkers used for the storage of coal to be loaded into vessels have usually been built out into the water, and as it is necessary to provide for vessels of deep draft, the substructure has necessarily been very costly, especially in salt water where timber work is exposed to the attacks of the teredo. An additional difficulty arises on account of tides, the extreme range at the Puget Sound ports being about 20 feet. In order to allow vessels to load at nearly all stages of the tide, a large amount of storage coal must be elevated to a considerable height, and, as a consequence, the cost of coal bunkers constructed on the ordinary plan is considerable per ton of storage capacity.

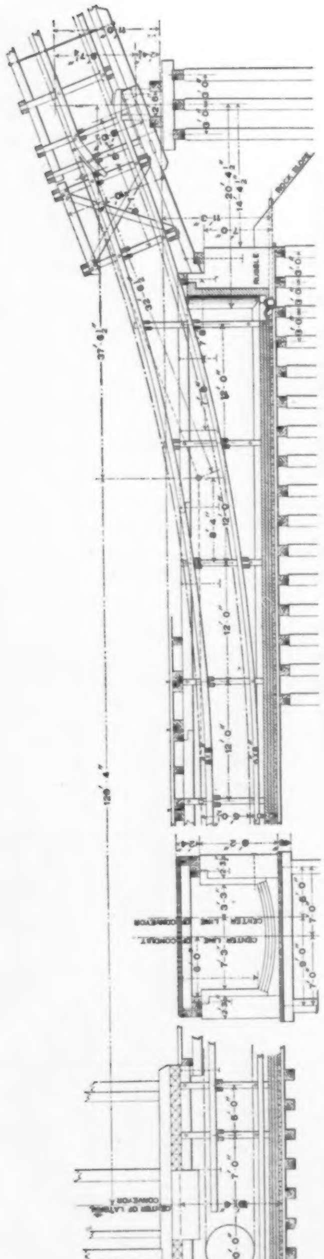
With the new plant advantage has been taken of the peculiar formation of the shore. From the water's edge the ground rises very abruptly to a height of several hundred feet, the formation being hardpan and cement gravel. On this bluff the foundation for the bunker has been prepared by excavating a slope of the proper angle to make the coal run freely.

The bunker itself consists of a box, with a sloping bottom, which has been set on this slope. The coal is dumped into the bunker from the top, two tracks running its entire length and being connected in such a manner as to make operation as convenient as possible. The engine pushes the loaded coal cars up on the tracks constructed behind the bunkers. They are then allowed to run back over the bunkers by gravity, are unloaded and collected when empty on one of the tracks below the bunkers, whence they are returned to the yards. The coal is taken out at the lower end of the bunkers through gates into conveyors, which run the entire length of the bunkers. There are two conveyors leading to the middle of the bunker, where coal is discharged into the sea conveyor, which runs at right angles under the yard tracks out to deep water. At the outer end of the sea conveyor provision is made for the tides and for the different loading stages of the vessels by a bridge 100 feet long, which is pivoted on one end and can be raised and lowered at the front end. The conveyors consist of a series of pans, four feet wide, two feet long and one foot deep, supported by wheels and running on light rails. They are driven by two electric motors, one 50 horse-power, at the head of the sea conveyor, and one of 20 horse-power, which can be thrown into gear with either of the lateral conveyors. The bridge itself is counterweighted and the raising and lowering is done by power furnished by the motor running the sea conveyor. To run the coal from the front end of the sea conveyor to the hatch of the vessel an extension chute is provided, which can be extended or shortened, raised or lowered by power. Only two men are required to operate the entire bunker. One is stationed at the particular gate of the bunker from which the coal is being taken. He regulates the flow of the coal into the conveyors. The other man is stationed at the front end of the bridge, where he has control of the motors and where a number of levers are arranged by which all the different movements are governed.

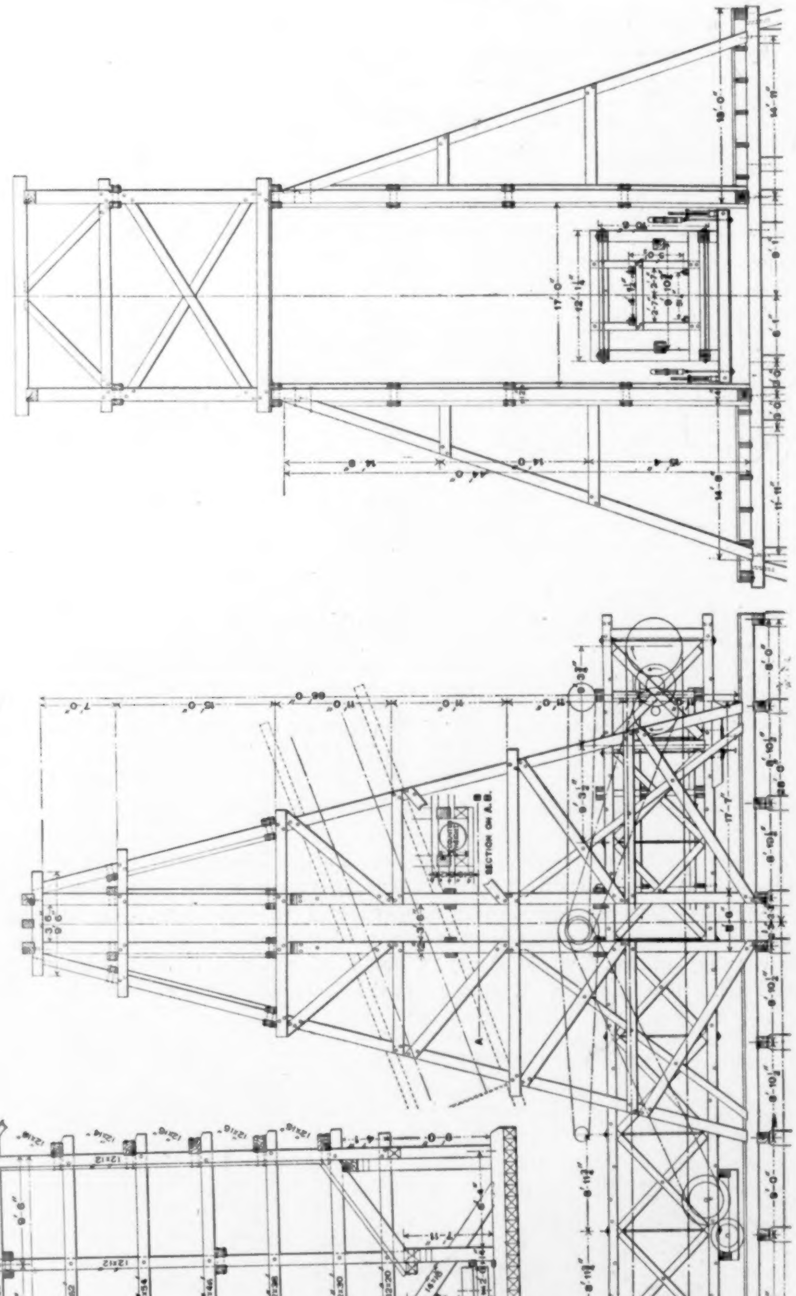


General View of Bunker and Chute Tower.

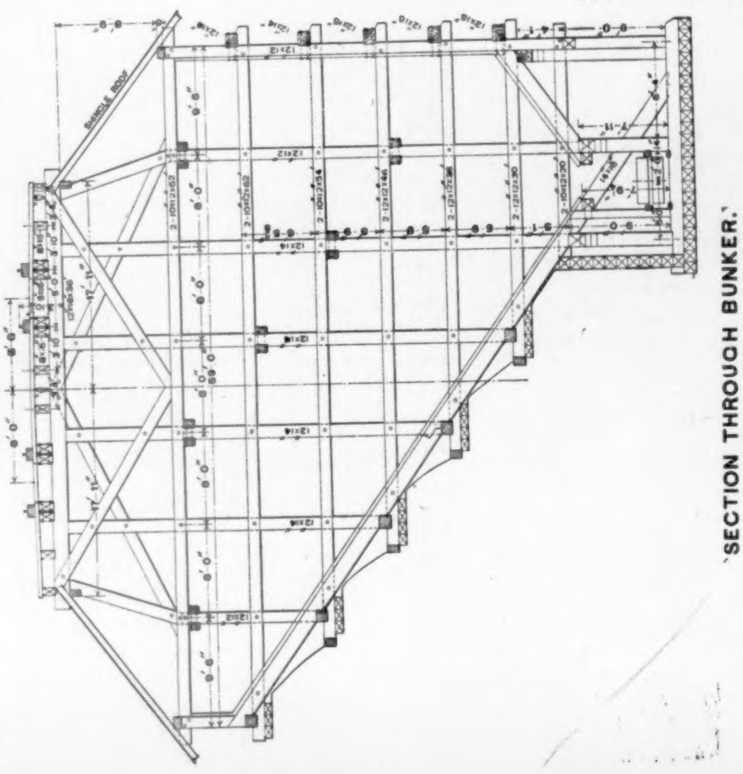
The machinery for the bunker was furnished by the Link-Belt Machinery Company, of Chicago. The specified capacity of



SECTIONAL VIEW OF SEA CONVEYOR CONDUIT.



SIDE AND END VIEW OF RIDGE AND TOWER.



SECTION THROUGH BUNKER.

the conveyors is 400 tons per hour, but it is found that the conveyor is capable of handling between 500 and 600 tons of coal per hour. The capacity of the bunker itself is 17,000 tons, enough for three or four good-sized cargoes. The average time consumed in loading a vessel is about 15 hours, depending somewhat on the dispatch it is possible to give to the trimming of the vessel. Since the bunkers first started no delay has occurred to any vessel on account of the stage of the tide. They have been able to take cargo on their arrival and finish it without interruption.

The adaptation of electric motors to these operations is of particular interest, and from an examination of the plans we reproduce it will be seen that by their employment a very simple arrangement of the machinery is made possible.

Compressed Air Traction.

The Hardie compressed air locomotive, designed and built by the American Air Power Company, 160 Broadway, New York, was illustrated and described in our issue of March, of the current volume, and in the May issue following we reprinted a statement of the cost of operating air cars on the 125th street line of the Third Avenue Railroad in New York. The interest which has been awakened by this experiment and by the one in prospect on the New York elevated roads makes it appear advisable to give the following resume of the present state of this equipment, which is taken from a recent publication by the company referred to:

Two street cars of the "Hardie" type were put in operation on 125th street on August 3d, 1896. They have operated since that date without accident or failure, and have carried 188,851 passengers and traveled 32,189 miles. Each car is provided with 51 cubic feet of air storage, and runs from 13 to 17 miles at average speeds and making usual stops, and can be recharged with air in less than two minutes. Mr. A. J. Elias, President of the Third Avenue Railroad Company, says as follows:

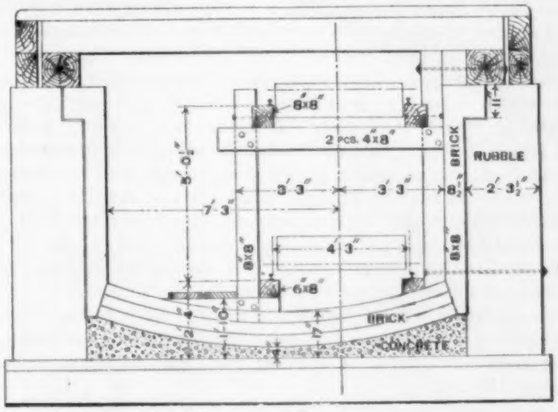
"Your cars, operated by compressed air, have been steadily operated on the 125th street line of Third Avenue Railroad Company since the 3d of August last.

"They have been easily handled, started, stopped and reversed, the last named quality being a very desirable feature, reducing the liability of accidents.

"Of course the advantage of a motor that operates independently of connection with any subterranean motive power is apparent.

"The motors are capable of attaining high speed and overcoming considerable gradients."

Signed statements of more than 200 residents of 125th street bear evidence to the fact that the service has been most satisfactory.



Section of Conduit.

Endorsements from these people who ride upon the cars daily, who see them continually in operation, and who depend upon them for service, and many of whom would like to see them replace all of the other cars upon that street, bear evidence to the popularity of these cars with the public.

Front View of Chute in Service.

The cars operated on 125th street are 28 feet long, and weigh 18,000 pounds each. The load being spring supported, they are easier and cause less wear of track than cars of the same design, size and weight by other systems. They can be run upon any railroad track and require no special construction and they can be gradually introduced into service, as existing equipment wears out, so as to require no large initial expenditure.

The machinery on the car and in the power station is of a simple character, slow in its movement, causing little wear and is maintained at a small cost.

The amount of free air used by these cars per mile operated to date is 460 feet, while for the last three months it has only averaged 409 feet. This air is stored in the motor at a pressure at starting of 2,000 pounds per square inch, and is reduced to working pressure by a specially constructed valve. A properly constructed power plant to operate 100 cars will compress this air at a cost of three cents per thousand cubic feet, including maintenance, labor, fuel and interest on the cost of the compressing station.

The pressure at which the air is to be stored in the cars being always known, it is merely necessary to provide sufficient strength of metal to hold it. The most careful inquiry fails to reveal a single instance in this country, since air has been used in operating machinery or motors, where anyone has ever been killed or seriously injured by it. The tubes used are in every instance tested within the elastic limits of the metal to double the pressure used in practice, and it takes about three times the actual pressure used to burst them, as shown by actual tests.

Locomotive No. 400, already referred to, was completed at Rome, N. Y., some months ago, and has been operated upon the tracks in that city.

It is now in New York waiting for an opportunity to run on the Manhattan Elevated Railroad. It has operated with same load and conditions as nearly as could be arrived at, at Rome, performing the service that will be required of it on the elevated structure, with a margin of air remaining. This was determined by measuring off a piece of track equal to the distance between the stations on the Manhattan Elevated and making the runs between these stations with the relative load, and stops, similar to the practice of

the Manhattan Elevated. Freight cars of a corresponding draw-bar pull of a Manhattan train were attached during these runs, and the motor performed the service in a noiseless manner and with ease. Frequently in getting out from the tracks of the locomotive works' yard heavy trains of freight cars on the siding were shoved back, and on one occasion 10 heavily loaded freight cars, aggregating a load of over 300 tons, were easily moved for some distance.

There are no principles employed in the operation of this locomotive which differ from those used in operating the air cars on 125th street, previously referred to. If given loads, speeds, grades, etc., are stated, the air consumption can be accurately determined, and there is no economic or mechanical reason why compressed air motors should not be employed in all city and suburban work.

Attention of steam railway people is called to a special design of car furnished us by a prominent Western railway, to which we have applied the Hardie motor. This car is 72 feet long, seats 130 people, with standing room for 50 additional passengers. This car carries sufficient air storage to run 28 miles with a single charge of air, and the motor, located on one of its trucks, has sufficient power to accelerate to a speed of 45 miles per hour, stopping at stations located 3,000 feet apart.

A modified form of car built on this plan will fit almost any kind of suburban service, and the motors, being noiseless and free from nuisance, may leave the main line on reaching the city and will be permitted in its streets on the same tracks with horse, cable, or electric cars.

Attention is also called to the design of double deck car now being supplied by this company for service in England, and designs are now being completed for snow plows for general street service in the city of New York.

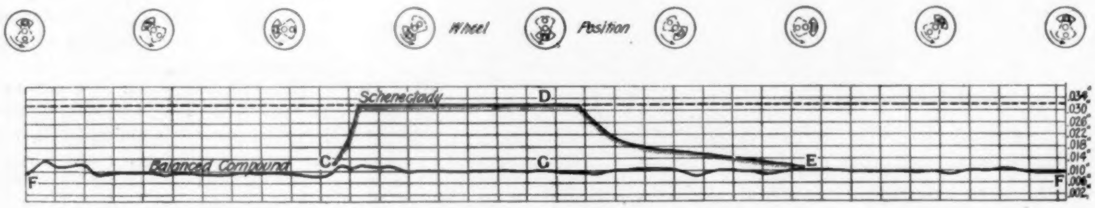
Tests of the Strong Balanced Locomotive.

Most of our readers are probably aware that a locomotive designed by Mr. Geo. S. Strong, and built by the Balanced Locomotive and Engineering Company, of New York, has been undergoing tests at the Laboratory of Purdue University under the direction of Mr. Geo. S. Morison, Vice-President of the Company, and Professor W. F. M. Goss, Director of the Laboratory.

This locomotive has four cylinders. It is of the compound type, and the high-pressure cylinders are placed between the frames while the low-pressure cylinders are outside of the frames. The low-pressure cylinders are connected to the driving wheels in the ordinary manner, and the high-pressure cylinders are connected to cranks in the forward driving axle. The high-pressure cranks are placed at 180 degrees from their corresponding low-pressure cranks, and the cranks of one pair of cylinders are at right angles to those of the other pair. The design possesses the interesting feature of high and low-pressure reciprocating parts of exactly the same weight, from which it is clear that the balancing of the reciprocating weights is perfect. The revolving weights are balanced in the wheels and in extensions to the cranks of the cranked axle. We expect to illustrate some of the special features of the design, including the valve motion, in a future issue.

Two series of tests have been made, one for the efficiency of the engine and one for the effect of the counterbalancing on the running of the engine. The report on the latter series has been made public and is entirely satisfactory in showing that the design of the engine is correct in this regard. The counterbalance tests were carried out after the manner adopted by Professor Goss and described in a paper by him read before the American Society of Mechanical Engineers, in December, 1894. This method makes use of small copper wires, which are passed between the driving wheels of the engine and the supporting wheels of the testing plant, while the engine is running. The indentations made in the copper wires by the wheels are measured to show the effect of the counterbalance weights on the pressure of the wheels against the rails.

The tests showed a maximum total variation in the thickness of the wire of 0.006 inch, and a comparison of the effects of the counterbalance of this locomotive and that known as Schenectady No. 1, upon which Professor Goss' earlier tests were made, is shown in the accompanying diagram. By an examination of this it will be seen that the counterbalance weights of Schenectady No. 1 raised the wheels entirely clear of the rails during a portion of the revolution. The line *C D E* of the diagram represents the wire from the locomotive as ordinarily counterbalanced, and the line *F G F* shows the effect of the balanced compound. In this comparison it should be noted that Schenectady No. 1 had driving wheels 62.5 inches in diameter and ran at a speed of 337 revolutions per minute, the excess balance being 400 pounds. The balanced compound has driving wheels 67.4 inches in diameter and ran at a speed of 323 revolutions per minute, there being no excess balance in this case. The nearly uniform thickness of the wire from the balanced compound shows that the weight or pressure of its driving wheels upon the rails is practically constant throughout the revolution of the wheels. From an examination of the diagram it will appear that the wire from Schenectady No. 1 increased in thickness as the counterbalance approached the upper quarter. In the tests it was observed that with the balanced locomotive there was almost a total absence of jerking forward and backward and of nosing. Both of these motions are quite noticeable in locomotives balanced after the usual manner, when they are running at speed upon the rollers



Comparative Effect of Counterbalance.

It is stated that there was almost no side swing of the front of the engine at speeds ranging from 30 up to 60 miles per hour, the latter speed being the maximum attained during these tests. Professor Goss' report upon the counterbalancing feature of the engine concludes as follows:

"Whatever the speed, the wheel pressure of the balanced locomotive will not vary except as the wheels may be acted upon by accidental forces, as, for example, impact due to inequalities in the track or changes in the position of the center of gravity of the heavier portions of the machine relative to wheels, through the engine rocking or tipping on its springs. The wheels at all speeds turn smoothly, while the machine as a whole remains almost motionless. Oscillations of every sort which appear in the balanced locomotive are of less than one-half the amplitude of those which attend the action of a locomotive of the ordinary type. It is evident, therefore, that the means adopted to secure perfectly balanced wheels have also served to greatly increase the steadiness of the locomotive as a whole."

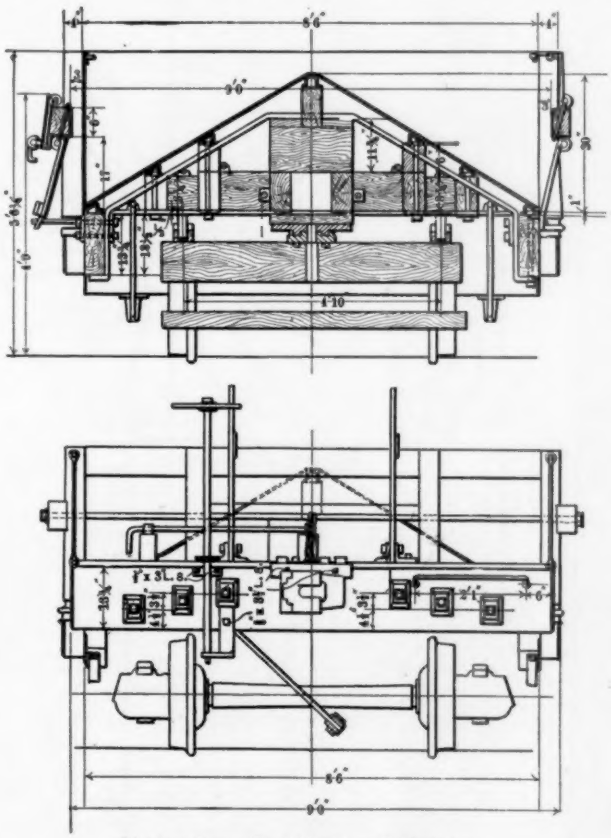
We expect to describe the efficiency tests in a future issue.

Cinder Car—Great Northern Railway.

By courtesy of Mr. J. O. Pattee, Superintendent of Motive Power of the Great Northern Railway, we illustrate a new design of cinder car which was devised with special reference to economy in loading and unloading cinders. The construction is such as to bring the sides of the car as low as possible for the purpose of cheapening the cost of loading by hand shovels.

The tops of the side sills are flush with the bottom faces of the center and inside intermediate sills, the outer intermediate sills being one-half inch lower than the inner ones. The top faces of the end sills are flush with the center sills, and the end sills are 13¾ inches deep. A cast-iron shield is placed on top of each sill. These are made in sections about 4½ feet long, and are used to prevent hot cinders which may be thrown into the car from injuring the sills. The car is lined throughout with No. 12 iron, and the ends are made of iron plates, as also are the doors. The 4 by 6-inch plates and the posts are sheathed with iron with a view of rendering hot cinders harmless to these members. There are four doors on each side of the car which are opened and closed by levers at the end of the car, each lever controlling two doors. The levers are held in place by an end door latch and buttons when the doors are closed. The doors are not only closed, but are pushed open by means of the levers, which is found to be advantageous when the doors are stuck by freezing. This mechanism after considerable experience is found to operate satisfactorily.

The novelty in the construction is that the car is low, and the side sills are dropped so as to gain every possible inch in the height through which the load must be shoveled. The total



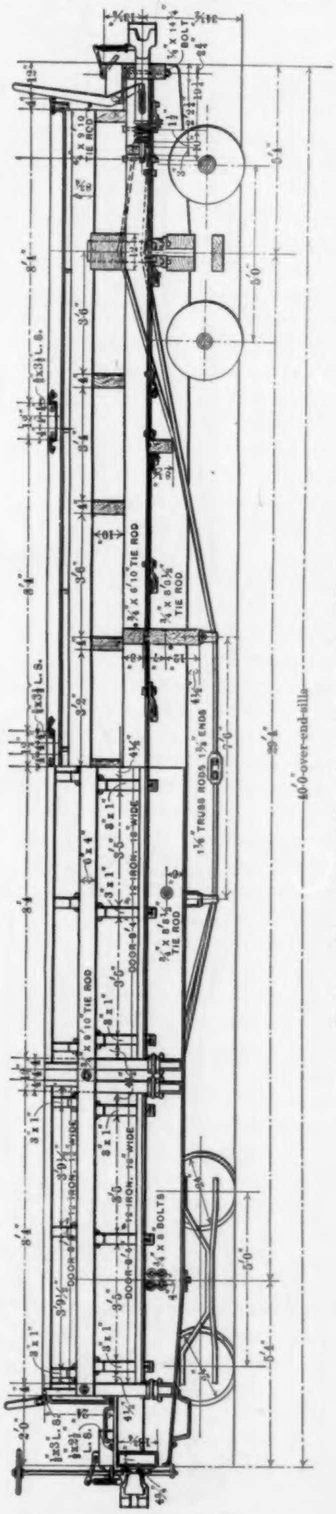
Cinder Car.—End View and Section.

height from the rail to the tops of the car sides is only 5 feet 6½ inches, and advantage is taken of the top doors to reduce the height to 4 feet 9 inches during the first part of the loading. These doors are hinged downward. It will be noticed that the wheels are small, being 24 inches in diameter, for the same reason, and the whole car appears to be about as low as it is possible to make it. The pitch of the inclined floor appears to be rather steep, but the slope was fixed after experimenting. The height of the ridge was first made 6 inches lower, but it was raised to facilitate unloading. Trial also showed the necessity of using six truss-rods, the location of which may be seen in the end view. The car is fitted with the American continuous draft rigging and with air-brakes, though the attachment of the brakes is not shown in our engravings. The design is by Mr. J. O. Pattee, Superintendent of Motive Power, and Mr. E. A. Wescott, Superintendent of Car Shops.

Modern Marine Boiler Furnaces.

The influence of the corrugated furnace upon the development of the marine engine to its present state has directed considerable attention to the furnaces and we reprint the following paragraphs from an article on the subject by D. B. Morison in *Cassier's Magazine:*

Corrugated furnaces are made from Siemens-Martin steel ingots, which are rolled into plates under ordinary plain rolls. Three sides of the plate are sheared, and on the fourth side the development of the saddle is marked and punched out. The plate is then taken to the bending rolls, where it is formed into a tube, after which it is heated by water gas, and lap-welded by hammers of special design.



Cinder Car.—Half Side Elevation and Half Section.

This welded tube is next heated in a special furnace and placed in the corrugating mill, in which complete corrugations are formed by one revolution; but a few turns are given for finishing, and after being allowed to remain until it is sufficiently cool, it is withdrawn as a perfectly cylindrical, corrugated tube. It is then taken to the flanging shop, where the back end is flanged by a hydraulic press, the final process being annealing. Furnaces for the British and other Admiralties are subjected to a pickling process in a solution of hydrochloric acid, which effectually removes all scale, and thus enables the most searching examination to be made.

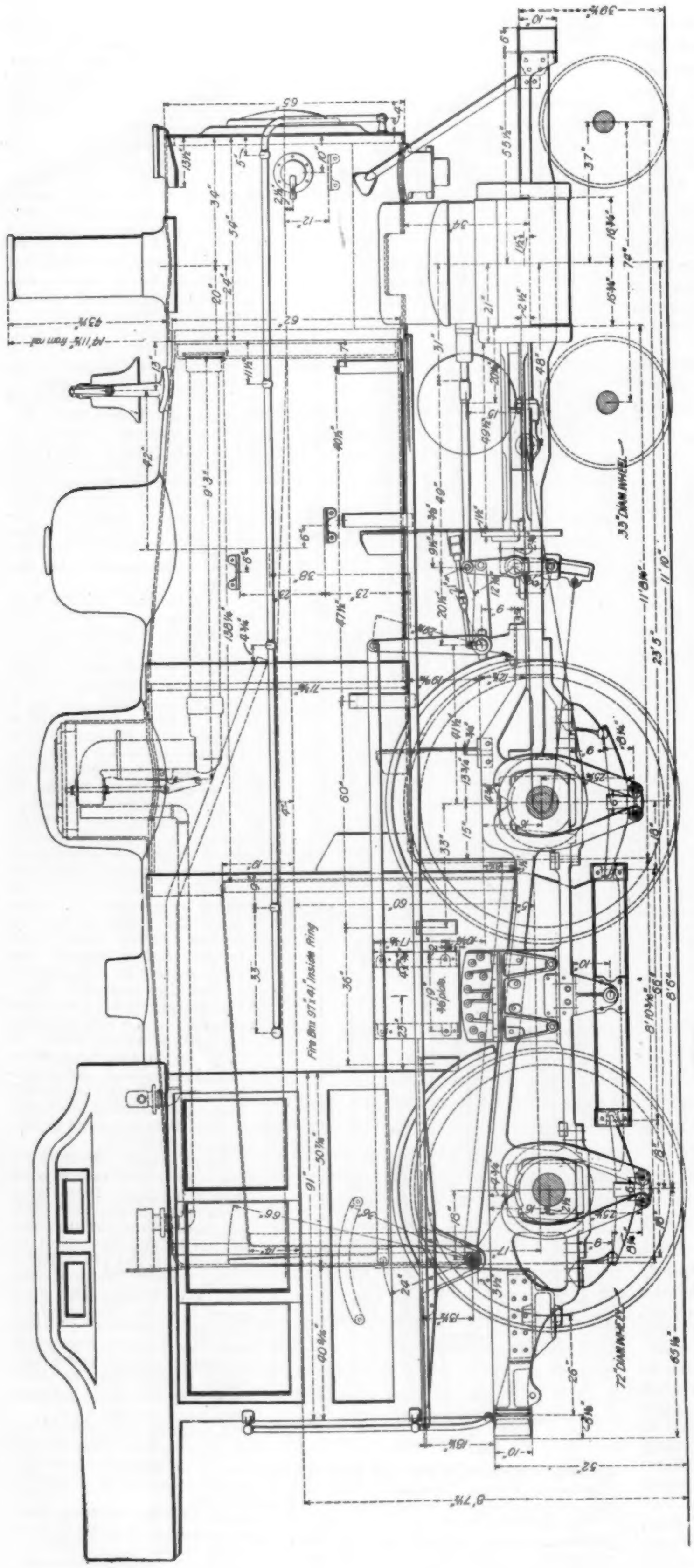
The furnace which was the greatest rival to that of Fox is that known as the Purves ribbed flue, made by Messrs. John Brown & Company, Limited, of Sheffield, England. This furnace consists of a series of thickened ribs, 9 inches between centers, the part between these thickened ribs being of plain cylindrical section.

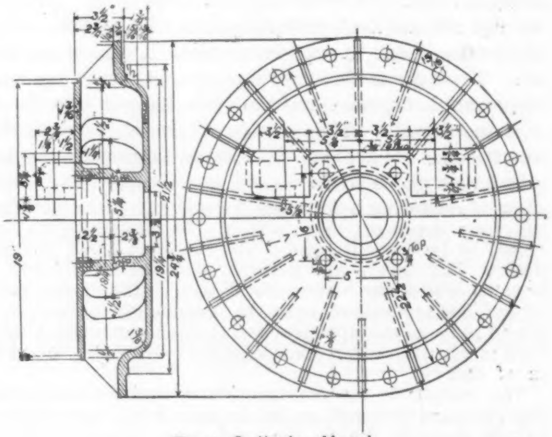
The Purves flue is made from a Siemens-Martin steel ingot. Rectangular section slabs, sufficient for two flues, are formed from these ingots under a hammer, the slabs being 7¼ inches thick, and their length being equal approximately to the length of the flue required. Special roughing rolls convert the slab into a ribbed plate 1¼ inches thick, which is then cut in two by powerful shears, and, after reheating, each half is passed through finishing rolls until the final required thickness is obtained.

After being sheared at the edges, the plate is bent into a circular form by a hydraulic press, and the edges are then welded together by the insertion of glut pieces, the plain parts being welded first and the ribs afterward. The furnace is then heated and converted into a circular tube by a very ingenious hydraulic press and afterward flanged in the ordinary way, the final process being annealing.

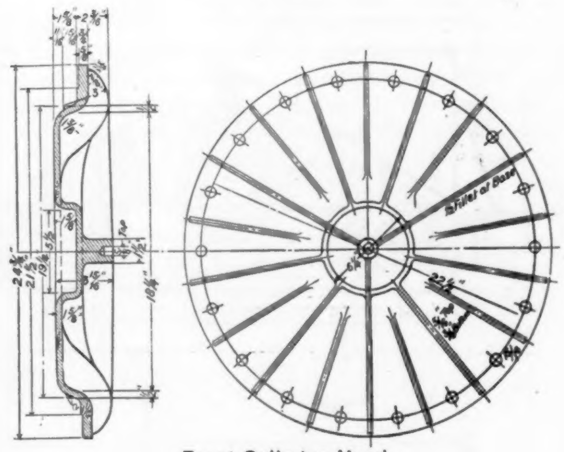
A later design, the Morison suspension furnace, is an improvement on the Fox corrugated type. It is manufactured by the Leeds Forge Company, Limited, in exactly the same manner, the same processes being employed throughout.

The suspension furnace consists of a series of long curves projecting inward toward the fire, each curve being approximately a catenary, or the form which a chain assumes when supported between two points. This long suspension curve is the feature of the furnace which has proved so successful in practice, as the tension is more uniformly distributed than in the Fox section, with its series of semicircles. There are no inward narrow cavities, and, consequently, there is less liability to local overheating, while the long inward curves present a more efficient heat-absorbing surface and there is considerably less tendency to alter in form under severe conditions of work.

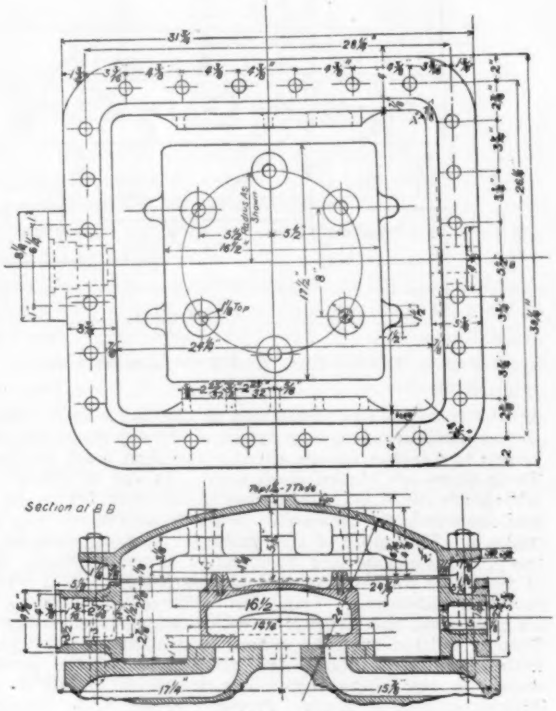




Back Cylinder Head.



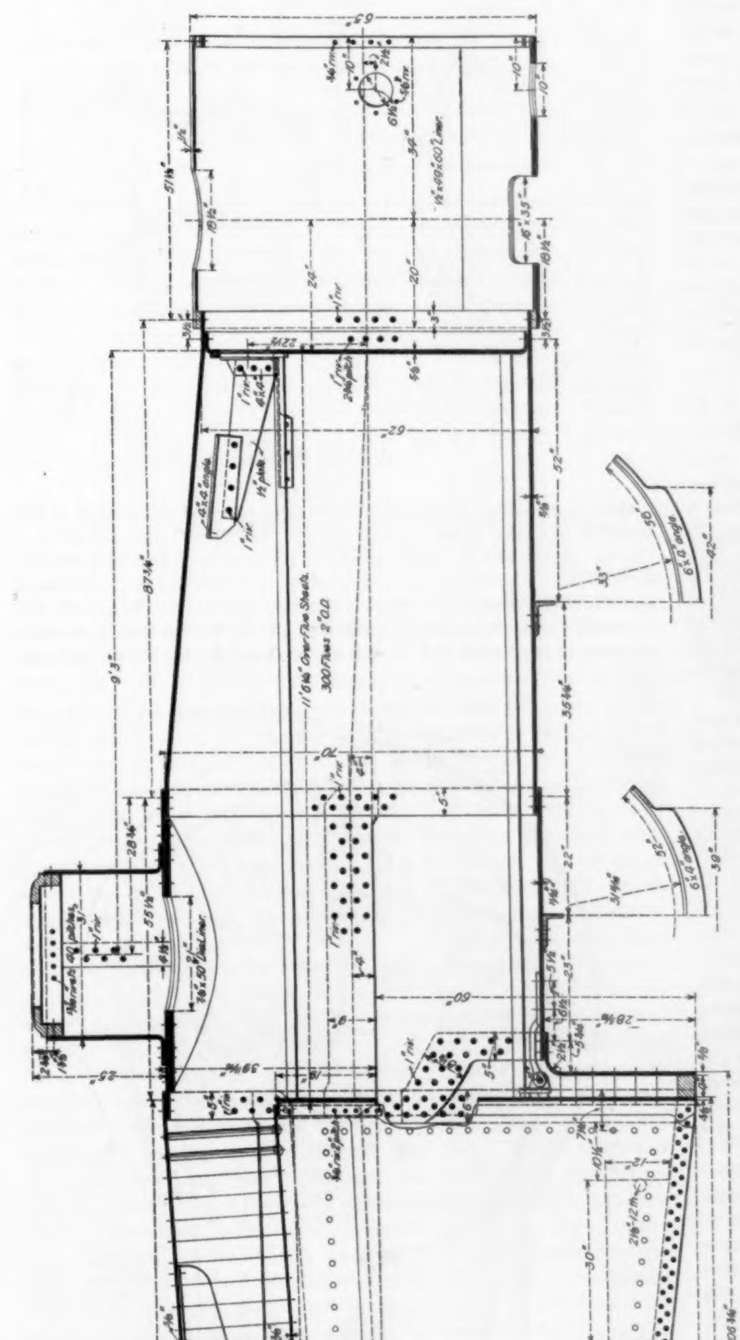
Front Cylinder Head.



Steam Chest and Cover.

EIGHT-WHEEL LOCOMOTIVE.–CHICAGO, INDIANAPOLIS & LOUISVILLE RAILWAY.

H. WATKEYS, *Master Mechanic.* BROOKS LOCOMOTIVE WORKS, *Builders.*



LONGITUDINAL SECTION THROUGH BOILER.

Details of Eight-Wheel Brooks Locomotive, Chicago, Indianapolis & Louisville Railway.

The general dimensions and specifications of the new eight-wheel locomotives recently built by the Brooks Locomotive Works for the Chicago, Indianapolis & Louisville Railway, the Monon route, were given with an engraving from a photograph in our August issue, and through the courtesy of the builders we now present some of the details of the design.

The side elevation shows the general appearance of the engine, the boiler outline, the running gear and equalizing arrangement. It will be seen that the frames are forged down and that the firebox is above them. The firebox is $50\frac{1}{8}$ inches wide outside and the frames are spaced 46 inches between centers. The weight of the back end of the boiler is carried upon a bracket resting upon a casting which imparts the load to both bars of the frame and bosses in the lower part of this casting support the driver brake hangers. The equalizer fulcrum is in the form of a yoke lipped against the inner face of the frame and carrying bosses at its lower end for the equalizer pin. The equalizer is an I beam 9 inches high and 69 inches long. Its center support is a casting fitted between the flanges on each side and held in place by four bolts. At the ends castings recessed for the ends of springs are fitted, and the web of the I beam is cut away to admit the springs. The springs are underhung and are seated on saddle castings from which curved links carry the load to the tops of the driving boxes. The outside ends of the springs bear against steel castings bolted to the frames.

The entire working deck of the engine and tender are on the same level. This was done for the convenience of the engine runner and fireman and it gives them the use of the whole floor of the cab which is flush from the front end of the cab to the back end of the coal space in the tender. From the photographic view shown last month the tender deck is seen to be level with the running board of the engine. The rear ends of the frames terminate in slabs to which the frame foot plate, of cast steel, is bolted. A 10-inch channel is placed across the ends of the frames and a strong ribbed cast-iron bracket from the foot plate bears against its front face while the rear face carries the chafing plate.

The small number of courses in the boiler has already been remarked and the longitudinal section shows their arrangement. The taper course is $\frac{5}{8}$ inch thick. The dome course is $\frac{11}{16}$ inch, the outside firebox sheet is $\frac{5}{8}$ inch, the crownsheet is $\frac{3}{8}$ inch, the side sheets are $\frac{5}{16}$ inch, the back firebox sheet is $\frac{3}{8}$ inch; the back head $\frac{9}{16}$ and the tube sheets are $\frac{1}{2}$ inch; the throat sheet is also $\frac{1}{2}$ inch. The back end of the boiler tapers downward and inward bringing the crown stays of of equal length in each row. The tubes are 2 inches in diameter, placed at $2\frac{3}{4}$ inches pitch and the spacing opposite the widest part of the firebox is radial instead of in vertical rows. As seen in the sectional view of the engine the feed pipes from the injectors are carried forward to about the usual location of the check valves. A liberal supply of washout plugs is provided, over the crownsheet, in the water-legs, and there are four in the front tube sheet, two near the bottom of the shell and one in the center of each side of the group of tubes. Two tubes are omitted in order to get in the last-mentioned plugs. The back heads are stayed with $\frac{1}{2}$-inch gusset plates, secured to the head between pairs of angles, while the attachment to the shell is by means of a flange turned over on the gusset, as shown in the combined end view and section of the

boiler. All of the rivet holes in the boiler are reamed in place.

Cast steel has been extensively used in this design and the weight thus saved is about 5,000 pounds. The cast-steel parts include the boiler expansion and supporting brackets, equalizer fulcrum and end castings, spring seats, driving boxes, footplates, driving wheel centers, steam chests and covers, pistons, crossheads, cylinder head and truck center casting. Several of these details are shown in the drawings and beyond a statement of the weight of the castings no description of them seems necessary. The weights in the rough are as follows:

Two pistons, 326 pounds; two front cylinder heads, 270 pounds; two back cylinder heads, 476 pounds; engine truck, center casting, 529 pounds; two steam chests, 532 pounds; two steam chest covers, 485 pounds, and two crossheads, 300 pounds. The crossheads are of the four-bar type and at 150 pounds each they are very light. The finished weights were not taken, but they are probably between four and five per cent. below the weights in the rough.

Master Mechanics' Association Subjects for 1898.

The proceedings of the American Railway Master Mechanics' Association for 1897 which have just been received from the Secretary, Mr. John W. Cloud, announce the following list of subjects for the convention of 1898:

Tonnage Rating for Locomotives; Advantages of Improved Tools for Railroad Shops: Best Form of Fastenings for Locomotive Cylinders; Best Method of Boiler and Cylinder Insulation; Efficiency of High Steam Pressure for Locomotives; Square Bolt Heads and Nuts and Standards for Pipe Fittings; Air-Brake and Signal Instructions, and the Apprentice Boy.

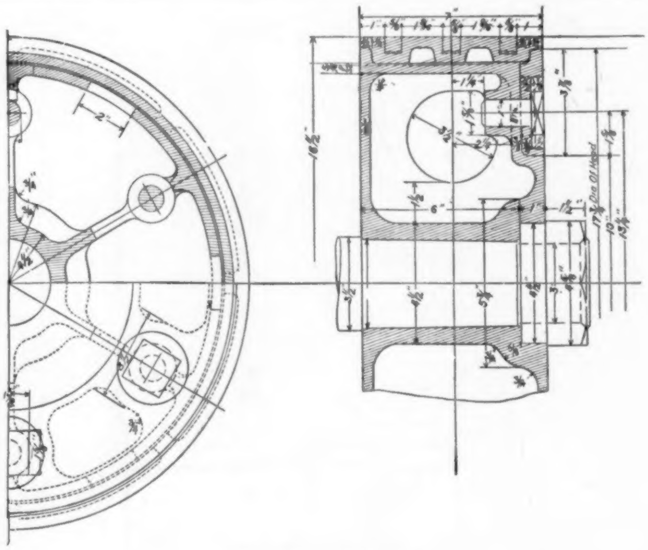
The subject Application of Electricity to Steam Railroads was made a part of the programme for next year and the following questions not reached at the last convention are carried over: The Special Apprentice; Arrangement of Front Ends of Locomotives to Clear Themselves of Sparks; Advisability of Systematic Course of Engineering in Connection with Technical Schools, and The Use of of Steel in Locomotives.

The Pneumatic System on Shipboard.

Captain Purnell F. Harrington, U. S. N., commanding the monitor *Terror*, senior member of the board appointed to examine the pneumatic system for working the turrets and guns, steering and refrigerating upon that vessel, has submitted a report to the Department which is of a more favorable tenor than many naval officials expected would be made. Captain Harrington according to the *Army and Navy Journal*, states the advantages of the pneumatic system as follows:

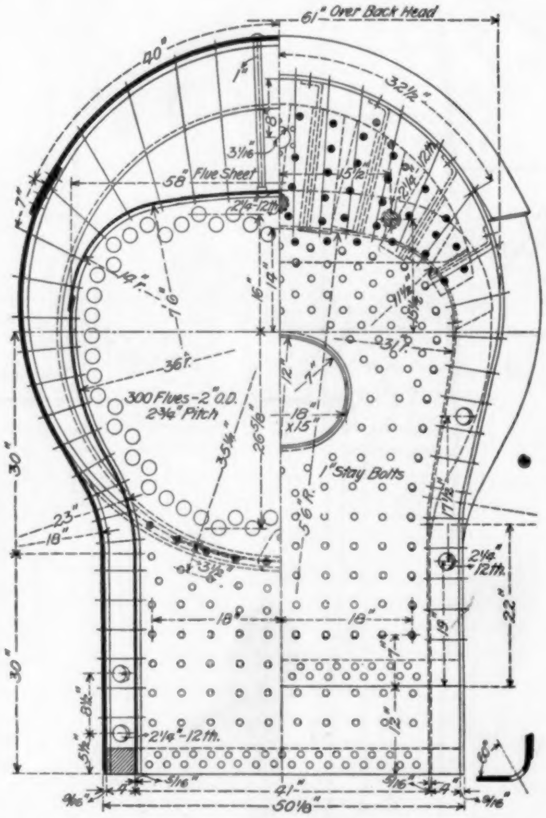
Whenever an air compressing engine is installed the power desired for any purpose may be obtained in excess of any steam pressure available. Air power motors may be substituted outside of the main engine-room everywhere below decks instead of steam engines, such as steering engines, anchor and hoisting engines. Those parts of the pipes would then have an agreeable temperature instead of being uncomfortably and hurtfully heated by the presence of steam pipes. Air leaks and broken air pipes impose no danger whatever, while steam leaks and broken steam pipes, particularly in action, are dangerous and alarming. Air leaks are quickly found and stopped, and they give no increase of temperature or flood of water or any personal inconvenience to those in the compartment. There is immunity from freezing pipes. Air motors require no special exhaust pipes, but the exhaust may be turned into the air or used for the ventilation of the compartment. Air motors may be started or stopped suddenly with little danger of injury to the motors. Compressed air is always ready for work, without freeing the pipes preparatory to starting motors.

The system is, in operation, as witnessed by the board, clean and free from danger and inconvenience, and free from difficulties in ascertaining or removing causes of trouble, which freedom is not inherent in any other system of turret and steering machinery. While the board is pleased with the pneumatic machinery on board the *Terror*, it recognizes the fact that it is an experimental design. The board is of the opinion that a new design would produce results even more satisfactory than those on board the *Terror*.



Cast Steel Piston.

The examination of the pneumatic system covered a period of five months, and the board describes as "excellent" the behavior of the turrets, guns and steering gear. It has been repeatedly demonstrated that when the ship is at a speed of from six to eight knots, and there is a pressure in the steering cylinders of 125 pounds per square inch, the helm can be moved by the air piston from hard over one side to hard over the other side (68 degrees) in seven seconds.



Section through Firebox.

The only criticism madeby the board relates to the air compressing engines. These, it declares, are of obsolete type, and run at low speed, and a recommendation is made that they be replaced by compressors of recent design which run at high speed.

Up to the present there has not been even a horse street railway in Siberia, but an electric line is now building in Vladivostok.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry applied to Railroads.—Second Series.—Chemical Methods.

XXI.—Method of Determining Proportions of Oil, Turpentine, Pigment and Moisture in Passenger Car Color.

BY C. B. DUDLEY, CHEMIST, AND F. N. PEASE, ASSISTANT CHEMIST, OF THE PENNSYLVANIA RAILROAD.

EXPLANATORY.

The standard passenger car color of the Pennsylvania Railroad Company, otherwise known as Tuscan red, is bought in the paste form, and the paste should contain only oil, turpentine and pigment. As a matter of fact, however, shipments always contain moisture in greater or less amount, and as both turpentine and moisture are volatile constituents, and as the amount of each has an important influence on the success of the paint, it is not sufficient to determine the sum of these two by difference, as moisture is generally determined in freight car color. Accordingly the following procedure has been devised for giving these four constituents in passenger car color:

OPERATION.

Weigh a six-ounce Erlenmeyer flask and then introduce five grams of the paste to be examined. The manipulation of the paste is not entirely easy. It is best to weigh the material into the flask, using a narrow spatula to transfer it and taking great pains to prevent any of the paste from getting on the outside of the flask, or near the top on the inside. Fill the flask about one-third full with 88 degrees Beaume gravity gasoline, and agitate with a rotary motion in a horizontal plane, until the paste is all decomposed. Now add more gasoline, and agitate in the same way to secure mixing, until the flask is about two-thirds full, and finally add gasoline from the jet of a wash bottle, so as to mix as thoroughly as possible, until the flask is nearly full. Cork loosely, without permitting the liquid to touch the cork, and allow to settle, which may require from two hours to two days. When the liquid is clear, carefully remove the cork and decant the liquid into a tall lipless beaker, which has been previously weighed, holding about nine ounces. By using sufficient care, the liquid may be decanted down so that not over five cubic centimeters are left in the flask. Some skill and a little experience are required to secure this result. Incline the flask and allow perhaps half the liquid to run out. Then, if the pigment has not already collected at the lowermost point of the flask, keep the flask inclined just enough so that the liquid will not run out, and assist the collection of the pigment at the lowermost point by striking the flask gently against the desk. If this operation roiles the liquid near the bottom of the flask, place it, still inclined, in the top of a beaker or other support, and allow to settle again, which usually takes only a short time. Then continue the decantation until the limit is reached. Place the beaker where the temperature is a little above the boiling point of the liquid and where there are no naked lights, and then fill the flask with gasoline again exactly in the manner described above. Allow to settle a second time and repeat the decantation in the same way. Enough of the liquid in the beaker will, if the evaporation is properly managed, go off while the pigment is settling the second time to furnish room for the liquid from the second decantation. Evaporate the liquid in the beaker as before, gradually raising the temperature as the liquid will bear it until a temperature of 250 degrees Fahrenheit is reached. Cool and weigh from time to time and continue the heating at the same temperature until constant weight is obtained. This weight, minus the weight of the beaker, is the weight of the oil. After the second decantation, cork the flask at once with a double perforated cork, carring two quarter inch tubes, one of which reaches to within an inch of the botton. Attach this tube by means of a rubber hose to an arrangement for passing air through concentrated oil of vitriol, and the other one to an aspirator, or any convenient suction. Pass air through the whole arrangement with occasional weighing, until the flask containing the pigment shows constant weight. Deduct from this weight the weight of the flask. The resulting figures give the weight of the pigment and they, together with the figures obtained from the beaker containing the oil, should be treated as described under "Calculations." Treat a second portion of five grams of the paste exactly in every particular as above described, except that after weighing the flask to be used with this second portion, one gram of anhydrous copper sulphate is weighed into it. This anhydrous copper sulphate takes up the moisture that is present in the five gram portion, and retains it in a condition to be weighed. The figures obtained from this flask are therefore the weight of the pigment plus the moisture plus one gram of anhydrous copper sulphate. These figures as well as those from the beaker containing the oil should also be treated as described under "Calculations."

APPARATUS AND REAGENTS.

The flasks and breakers required are perhaps sufficiently designated above.

The arrangement for taking moisture out of the air used in drying the pigment by causing it to bubble through concentrated oil of vitriol may perhaps be readily improvised in every laboratory. Drechsel's wash bottles for washing gas, with ground glass joints, are very convenient for this purpose.

The gasoline specified is readily obtained in the market. It is best to obtain it in tin cases, and every new shipment should be tested. If the same amount used in an analysis leaves a weighable residue, when a blank oil determination is made, a correction corresponding to this should of course be made. It is better, however, to secure such a grade of gasoline that no residue will be left. If the gasoline is not shipped or stored in wood or dirty cans, very little difficulty will occur.

The anhydrous copper sulphate is made by heating the ordinary crystallized salt in a porcelain dish, over a Bunsen burner, until it becomes white and pulverulent. Stirring with a glass rod facilitates the operation. High temperatures are not required.

CALCULATIONS.

The figures obtained by deducting the weight of the beaker from the constant weight of the beaker and oil give the weight of the oil in 5 grams of the paste. The figures from either 5-gram portion may be used for this calculation, as long experience shows that these figures give results which are frequently identical, and rarely differ more than a quarter of one per cent. Let us suppose the weight of oil to be 0.4340 gram. Then the percentage of oil would be (0.4340 × 100 ÷ 5) 8.68. Still further, let us suppose that the figures obtained from the flask containing the pigment of the first portion are 3.9885 grams. Then the percentage of pigment would be (3.9885 × 100 ÷ 5) 79.77. Again, if we add together the weights of the oil and pigment obtained from the first portion, we have 4.4225 grams, which represent the weight of the oil and the dry pigment, the moisture having passed off during the drying. Adding together also the weight of the oil and the weight obtained from the flask containing the pigment of the second portion and we will have, let us say, 5.5200 grams. One gram of this is the anhydrous copper sulphate, which we added. Deducting this we have 4.5200 grams, which represents the weight of the oil, pigment and moisture of the second 5-gram portion. But from the first 5-gram portion we have the weight of the oil and dry pigment, viz., 4.4225 grams. The difference between these figures, or 0.0975 gram, represents the moisture, and its percentage would be (0.0975 × 100 ÷ 5) 1.95. Finally, the percentages of oil, pigment and moisture being known, their sum (90.40) deducted from 100 gives the percentage of turpentine, viz., 9.60.

NOTES AND PRECAUTIONS.

It is quite apparent that this method involves as its principal features the insolubility of the pigment in gasoline, the solubility of the oil and turpentine in the same menstruum, the volatility of the mixed turpentine and gasoline without vaporizing the oil or pigment, the possibility of removing the moisture from one portion of the pigment by means of dry air, and the possibility of capturing the moisture in another portion by means of the anhydrous sulphate of copper.

It is well known that commercial spirits of turpentine is rarely

free from a residue of either pitch or resin or both, which does not volatilize on exposure to dry air. This residue, of course, appears in and is weighed as oil in the method above described. The amount of this residue rarely exceeds 2 or 3 per cent., and as the maximum percentage of turpentine in the paste cannot be more than 18, the error thus introduced will at most be only a few hundredths of one per cent.

It is probable that there is a slight oxidation of the oil during the evaporation and subsequent drying to constant weight. Direct experiments on oil free from moisture, however, show that the change in weight due to this oxidation is very small. Mülder has shown that during exposure to the air, especially at high temperatures, linseed oil loses carbon and possibly hydrogen, while it gains oxygen, and experiments made for this purpose show that the loss and gain very nearly balance each other, so that the error introduced during the drying can safely be ignored.

The pigment of passenger car color gives much less difficulty from slow settling than often happens in freight car color. This is apparently due to the fact, that by the requirements of the specification, not less than 74 per cent. of the pigment must be anhydrous sesquioxide of iron, while of the remaining 26 per cent., from one-third to two-thirds may be the organic coloring matter required to produce the shade, so that there is very little space left for clay, gypsum or other hydrous substances which apparently cause most difficulty in settling.

It should be mentioned that in actual practice it is rare to obtain oil to weigh, that is absolutely free from pigment. This may arise from the fact that a little extremely finely divided pigment remains suspended in the liquid, especially before the first decantation, or from disturbance of the settled pigment during the decantation, or possibly from solution of some of the organic coloring matter in the menstruum. With proper care during the decantation the error from these causes is believed to be very small.

If the paste contains 9 per cent. of oil, as is desired and expected, the amount of oil in five grams would be 0.4500 gram. About 150 cubic centimeters of liquid is present before the first decantation, and by the supposition $\frac{5}{150}$ of this are left after the decantation is finished; that is $(0.4500 \times 5 \div 150)$ 0.0150 gram of oil is left. But if the directions are followed, $\frac{5}{150}$ of this are left after the second decantation; that is $(0.0150 \times 5 \div 150)$ 0.0005 gram of oil are left with the pigment and weighed with it. This amounts to an error of $(0.0005 \times 100 \div 5)$ 0.01 per cent. If greater accuracy than this is desired a third treatment with gasoline can be employed.

The separation of the liquid from the pigment by decantation is much better than to use a siphon. Formerly a siphon was employed, but it was found that there was a little loss due to material adhering to the siphon, and also the liquid could not be drawn off so as to leave as small a volume behind, on account of the currents at the inlet end disturbing the pigment.

The directions require that both the oil and pigment be dried until constant weight is obtained. It is probable that, especially with the oil, absolute constant weight would never be obtained. If the difference between two weighings an hour apart does not exceed one or possibly two milligrams, the resulting error will be so small, as is readily seen, as to have no practical importance.

The directions to put the paste low down in the flask during the weighing, and to prevent the liquid from touching the cork, are perhaps of more importance than would appear at first sight. The difficulty of avoiding loss while decomposing the paste, if it is near the top of the flask, is quite considerable, and the loss if the liquid touches the cork is much more than would be supposed.

Gasoline is quite sensitive to changes of temperature, and its vapor tension even at ordinary temperatures is quite considerable. If the flask is tightly corked, therefore, there is danger of loss of both flask and its contents.

There seems little doubt but that dry air will remove all hygroscopic moisture from pigment. Direct experiments made for the purpose show that after constant weight has been obtained, if water is added to the flask, and the evaporation repeated, the same constant weight is readily obtained again. Furthermore, it seems fair to consider all water not removed by dry air as a legitimate constituent of the pigment.

It should be mentioned that since the bulk of pigment in the flask is quite considerable, cases may arise where hygroscopic moisture will be mechanically held in the pigment and constant weight obtained before all the moisture has passed away. This difficulty may be avoided by distributing the pigment over the sides and bottom of the flask, just before all visible liquid disappears. The distribution is easily made by turning the flask down on its side and revolving it slowly in the hands. With a little experience the layer of pigment is easily spread over so large a surface, that the danger of entrapped moisture is very small.

The power of anhydrous copper sulphate to take up moisture is very great. If from any source, as for instance through a leaky tube, undried air is taken into the flask containing the copper sulphate, the determination is rendered worthless and must be repeated, owing to the taking of moisture by the anhydrous copper sulphate from the undried air. Numerous experiments show this beyond question. There seems, therefore, little reasonable doubt but that the anhydrous copper sulphate does actually capture and hold all the hygroscopic moisture present in the five grams of paste to which it is added. Also the necessity of preventing the accession of any considerable amount of undried air to the flask containing the anhydrous copper sulphate during the whole operation is apparent.

Experience indicates that concentrated commercial oil of vitriol used in drying the air becomes soon so diluted as to be inefficient. It must be renewed every two or three determinations. A very good arrangement is to have two or three Drechsel wash bottles, containing acid, in series, renewing from time to time the one next the flask, pushing the others down in order at each renewal.

The reason why, in getting the moisture, the sum of the oil and pigment obtained from the first portion is taken from the sum of the oil and pigment obtained from the second portion, instead of using the figures representing the pigment, in both cases, is because in this way the possible error introduced by failure to effect absolute separation of oil and pigment is avoided. If, as has already been stated, the percentages of oil obtained from the two portions differ a quarter of a per cent. with corresponding differences in the pigment, it is obvious that, if the pigment figures are used, an error to this extent would be introduced into the moisture determination, which may easily be avoided.

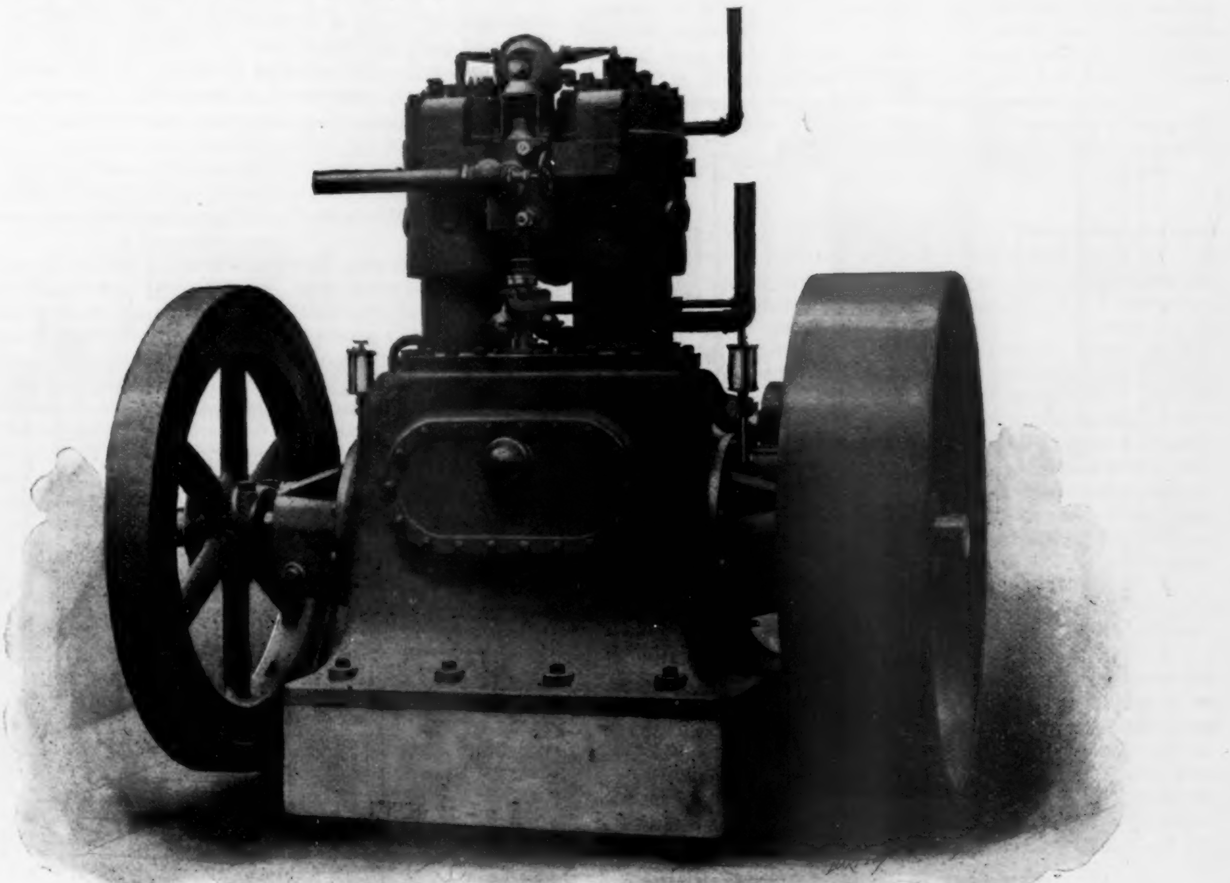
The Westinghouse Gas Engine.

The new gas engine which has recently been placed on the market by the Westinghouse Machine Company is the result of an extensive series of experiments. Sizes varying from 5 to 250 horse-power have been built and tested, and one of 750 horse-power is now under construction. The gas engine is believed to be fully the equivalent in design and workmanship to the steam engines by which these builders are so widely and favorably known.

In its general design the gas engine embodies the important features of the steam engine already referred to, the upright self-contained construction and the self-lubricating principle being particularly apparent. The cylinders, two in number on the smaller sizes and three on the larger sizes, are cast from a special mixture of hard, fine-grained iron, bored and finished with a high degree of accuracy. The pistons are of the trunk pattern, cast from the same quality of iron as the cylinders, and made very long in order to serve the purpose of a cross-head, without causing troublesome wear of the cylinder walls. The piston is packed with cast-iron spring rings, which insures a maximum of tightness and long life. As in the steam engines, the piston carries a case-hardened steel wrist pin, accurately ground to size, with which the upper end of the connecting rod engages. The connecting rods are forged from steel, the ends being fitted with adjustable bronze boxes lined with

the best quality of genuine babbitt metal. The adjustment of the piston end of the connecting rod, usually a difficult operation in trunk piston engines, has been taken care of in a particularly ingenious and convenient manner. The shaft is a forging made from the best quality of open-hearth steel, the cranks being forged solid and slotted out. The shaft is machined all over and is particularly strong and heavy.

The bearings are all adjustable, the lower halves being set up by wedges operated by screws. As the wear on the bearings is always downward, the upper halves preserve their original position. In taking up the wear, the wedges are drawn across until the shaft is brought up against the upper halves of the bearings. This construction insures the proper alignment of the shaft after each adjustment, as it has of necessity to come back exactly to its original position. It also preserves the original clearances, and consequently the same degree of compression, which has much to do with the economy. Maintaining a constant hand this company furnishes a simple and effective air compressor and an air storage tank of ample capacity. The air compressor can be operated by hand to charge the tank for the first time, after which it is run by a belt from any convenient pulley either on the engine itself or on the shafting. By running the compressor a few minutes every day the tank is kept fully charged and ready for starting the engine at any time. A pipe leads from the air tank to one cylinder of the engine, in which pipe is a valve arranged to be opened and closed at each revolution of the engine, by means of a cam on the end of the shaft which operates the exhaust valves, the opening occurring just as the crank is passing its upper center. A single motion of a lever on the crank case sets the exhaust valve on this cylinder so that it opens on every return stroke of the piston, instead of every other stroke, as when the engine is in normal operation. A turn of a screw throws the admission valve on the same cylinder out of operation. It will readily be seen that one cylinder of the engine is now converted into a compressed-air motor, without disturbing the functions of the other cylinder or cylinders. The engine being set with the crank a little past its upper center, the air and gas inlet valves properly adjusted, and the stop valve on the air tank opened, it starts up and continues to run on the air pressure until explosion takes place in the other cylinder. The stop valve is then closed, the inlet and exhaust valves set again to work in the regular manner, and the engine is in full operation. The air admission valve can be disengaged from its cam when not in use.



Front View of 70 Horse-Power Westinghouse Gas Engine.

height, from the base of the engine to the center of the shaft, is a specially desirable feature where the engine is connected direct to an electric generator or other machine.

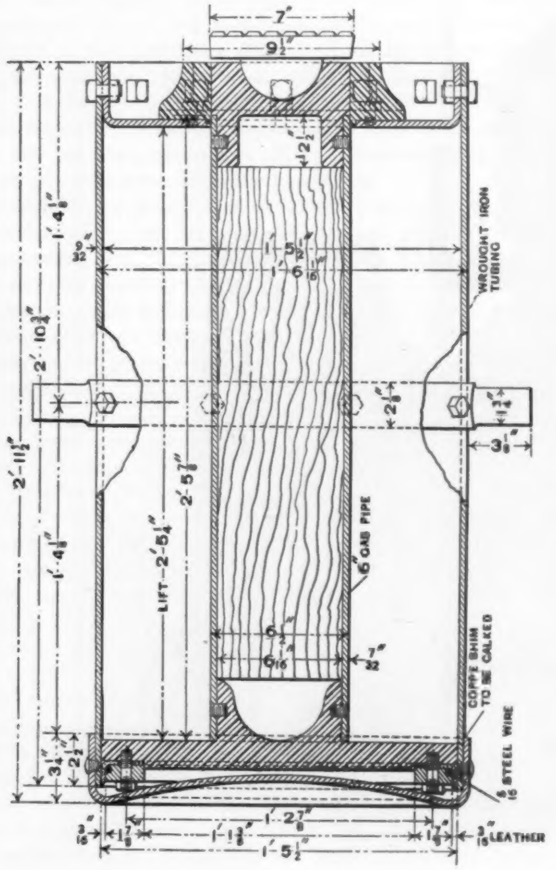
The ignition of the explosive mixture is accomplished by the electric spark. The igniters are simple in construction and exceedingly durable. They are mounted in small castings, easily removed and replaced. In sizes from 15 horse-power up double igniters are provided in each cylinder. One igniter only in each cylinder is in operation at any one time, the other being held in reserve.

Small gas engines are easily set in operation by giving the fly-wheel several turns by hand until a charge of gas and air has been drawn in, compressed and exploded. In the larger sizes this method is too laborious, requiring the combined efforts of several men, besides being attended with more or less danger from the sudden starting when explosion takes place.

With the engines which are too large to be readily started by

These engines operate on the Otto cycle. On the first outward stroke the piston draws in a charge of the explosive mixture, which it compresses on the return stroke. As the crank passes the center, the charge is ignited and expansion takes place on the next forward or working stroke. During the succeeding return stroke the burnt gases are expelled, leaving the cylinder ready to repeat in regular order the same series of opera-

tions. The single-acting piston receives in consequence only one impulse for each four strokes, or each two revolutions of the crank. This feature at once places the single-cylinder engine at a disadvantage in the matter of steady rotative speed. The disadvantage is still further aggravated by the common "hit-and-miss" system of governing, in which the regulation is effected by varying the frequency of the explosions, leaving the intensity the same. At full load such an engine receives an impulse every second revolution, while on lighter loads the impulses may be as infrequent as one in every eight or ten revolutions. Such a method of governing cannot be either quick or sensitive, and while perhaps reasonably satisfactory when running under steady load or driving machinery in places where good regulation is not essential, it is particularly unsuited for the exacting requirements of electric lighting, especially since the advent of high efficiency lamps, on which the effect of bad regulation is disastrous. This shortcoming is compensated for, in a measure, by

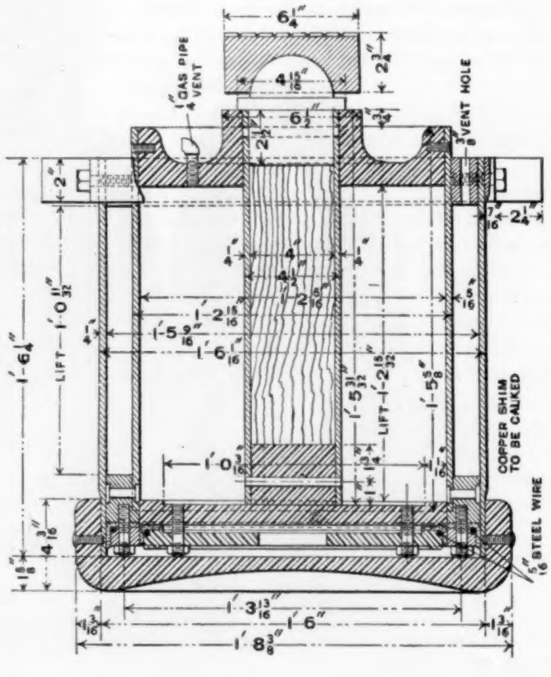


the use of extraordinarily heavy flywheels on the engine itself, often supplemented by auxiliary flywheels on a jack shaft or on the shaft of the dynamo. Even with the greatest precautions, the explosions in the engine can often be counted by the changing brilliancy of the lamps in circuit, and always by fluctuations shown by a reasonably sensitive voltmeter.

By the use of two cylinders alternating the working strokes of the pistons the Westinghouse gas engine receives an impulse at every revolution. A sensitive governor regulates the amount of the explosive mixture admitted for each charge, in proportion to the load on the engine, giving an impulse at every revolution whether running fully loaded or entirely light. On this account, for smooth running and steady speed, it is said to be equaled only by the best steam engines, and these essential and desirable qualities are obtained without overloading the shaft with enormous flywheels. This claim is substantiated by the fact that these engines have been successfully operated when connected direct to dynamos.

Pneumatic Jacks for Lifting Locomotives.

In locomotive repair shops not equipped with overhead traveling cranes portable power jacks for such work as lifting locomotives while taking out or putting in driving wheels are very convenient and the accompanying engravings show a design for this purpose as worked out and used by Mr. J. H. McConnell, Superintendent of Motor Power of the Union Pacific Railway. These appliances are not new in principle, but the application of compressed air to the lifting of such heavy weights is interesting, as is also the telescopic feature of one of the pair of jacks shown. The single lift jack has but one piston and lifts 29¼ inches. It is used under the rear end of the engine and the telescopic jack is used under the front end. The larger piston of this jack has a lift of 12 inches and the smaller piston lifts nearly 15 inches more. Wrought-iron tubing is used for the cylinders and piston rods and the packing for the pistons is of leather turned over rings of wire 5/16 inch in diameter. There are four castings in the telescopic form, one of them being the base casting and in the single lift jack the base is made of pressed plate. Both jacks are designated as 17½ inches in diameter. A convenient form of two-wheel truck constructed of iron with a wooden tongue is provided for transporting each jack and they are operated by



one man exclusively. The engravings show the trunnions used for carrying the jacks about. The air pressure is applied by means of a pipe leading from the base of the jack to an ordinary hose coupling for attachment to the shop air hose. Mr. McConnell states that they have been found much superior to ordinary ratchet jacks and it is easy to see that they afford a means for a great saving in time in making the lifts. The engravings do not appear to require further explanation, except to call attention to the wooden filling of the piston rods.

Master Car and Locomotive Painters' Association.

The twenty-eighth annual meeting of the association will be held at Old Point Comfort, Va., Sept. 8, 9 and 10, at the Hygeia Hotel. A special rate of $3 per day has been secured for members and their wives. The list of subjects for discussion is interesting and an instructive meeting is expected. Mr. Robert McKeon is Secretary of the Association with office at Kent, O.

The Great Siberian Railroad and the Present State of Its Construction.

(Special Correspondence to the *American Engineer, Car Builder and Railroad Journal.*)

(CONTINUED FROM PAGE 234.)

THE EASTERN SIBERIAN OR AMOUR RAILROAD.

The surveys of the line connecting the Acriminus of Transbaikal Railroad with the Oussouri Railroad, along the left shore of Amour River, were very difficult; $500,000 was appropriated for that purpose. The surveys were begun in 1894 and ended in 1896. They gave the following results: The length of the line from Pokrovska to Khabarovk will be 870 miles, and the cost together with rolling stock $50,125,000, or $57,610 per mile.

The construction of this line will be postponed to an indefinite time, for it is found more convenient to connect the Transbaikal line with the Oussiri line or rather with a point of it near Vladivostok by means of a line located in a great part across China. This new line the Eastern Siberian Railroad planned to extend from the station Onon of Transbaikal Railroad to Station Nikolskoie of Oussouri Railroad, 1,280 miles long, consists of three sections: 1st, the branch of Transbaikal Railroad, from Onon to the China boundary, 293 miles; 2d, the Eastern China Railroad, 920 miles, across the two China provinces; Khei-lun czian and Ghirin, and 3d, the Oussouri branch, 67 miles from the China boundary to Station Nikolskoie. Both branches will be constructed by the Russian government; the Eastern China Railroad will be constructed in five years by the company of the Eastern China Railroad, incorporated by the China-Russian bank, and being under the control of Russian Finance Minister.

On the line of the Eastern China Railroad only reconnaissances and topographic surveys along the designed direction were made in 1896. The definite location will be determined in 1897, and the construction will be commenced in August of this year.

It is obvious from the above that the railroad line along the left shore of Amour will not be built, and so the Amour territory will remain without any high way, having as yet not even a wheel road across it. Therefore the construction of a highway along the left shore of Armour will have great importance for the country. Such a road is projected by the Minister of Ways and Communications; it will be 850 miles long and cost about $5,500,000. It is designed with gradients not more than five per cent., with radius of curves 175 and 105 feet, with grade 21 feet wide (14 feet macadamized), with timber bridges and post station houses.

This highway will be located in the direction chosen for the intended Amour Railroad.

THE OUSSOURI RAILROAD.

The Oussouri Railroad, from Vladivostok, on the Pacific Ocean, to Khabarovsk, is 479 miles long. It consists of two divisions:

I. The South Oussouri Railroad, from Vladovostok to Grafskaia, 227 miles long, with three miles of branches. It was begun in 1891 and is now quite ready, and has cost $10,290,000, or $49,000 per mile.

II. The North Oussouri Railroad, from Grafskaia to Khabarovsk, 252 miles long, with 3¼ miles of branches. It was begun in 1894 and will be completed in 1898. The cost of it is estimated at $10,855,000, or $43,000 per mile.

The South Oussouri Railroad has been damaged very much by the inundations of 1895 and 1896; so that the reconstruction of grading and bridges requires $550,000.

The state of construction of the North Oussouri Railroad is given by following figures: The clearing is completed; grubbing is 73 per cent. done; 227 miles of temporary roads are ready. Earthworks on the main line: 6,261,000 cubic yards or 90 per cent. of the whole, is made; on the Amour harbor 30 per cent., on the Amour branch 74 per cent.; on stone culverts and small bridges 91 per cent. of stone work is made; 50 per cent. of iron girder are erected; 98 per cent. of timber bridges are finished. Of the great bridges across the rivers Iman, Bikin and Khor, about 50 per cent. of stone work is done, and of 11 caissons, 5 are sunk and 1 is under construction; of 9 spans of 210 feet each, 4 spans are erected and 3 have been carried from European Russia. The track is laid on 101 miles of main line and 8 miles of branches, and 9 miles of station sidings; 580,000 ties are prepared, and 240,000 ties are already laid in track. The telegraph is built on 90 miles. Of line buildings, 21 section houses, and 25 small section houses are ready; besides them on 10 stations the passenger houses and all other buildings are building.

The construction of the Oussouri Railroad goes slowly in consequence of very difficult local conditions. In 1896 two inundations and a very rainy summer and autumn (15 rainy days a month) obstructed the progress of work. The population is very small, and the cold and dry winter and hot and moist summer, together with marshy ground, generate many chills, rheumatic and fever sicknesses.

The Oussouri Railroad was that link of the Siberian Railroad which was begun in 1891, the commencement of construction being inaugurated by the Csarevitch Nicolas (now Emperor). The provisory traffic was opened in sections in 1893 and 1894, and has given the following gross receipts for freights and passengers:

In 1893 year from November 1	25,453 roubles.
" 1894 " " " "	262,253 "
" 1895 " " " "	790,355 "
" 1896 " till October 1	654,106 "
Total	1,741,167 "

THE VLADIVOSTOK PORT.

The Vladivostok is the eastern terminus of the Great Siberian Railroad, and therefore it will have a well-equipped commercial port. To that purpose the bay of "Golden Corn" in the south bank of peninsula Mouravier Amourski can be utilized. This bay situated on 43° 6′ 51½″ of northern latitude and 149° 36′ eastern longitude is about 3 miles long and 1 mile wide, and has a depth varying from 26 to 66 feet, and is protected against all winds. However, in winter the bay is covered with ice, but this defect can be met by means of two or three ice breaking steamers.

For fitting this port a landing harbor 2,100 feet long is designed, which shall lessen the cost of landing, this now being about $1½ per ton. The cost of this construction is estimated at $635,000.

THE AMOUR RIVER.

The construction of the link connecting the Transbaikal Railroad with the Oussouri Railroad will not be completed until 1903, and if the other lines are completed in 1898, then from 1898 till 1903 the Amour River from Sretensk to Khabarovsk will be the important connecting link of the Great Siberian route. The navigation on this portion of the Amour (Sretensk-Khabarovsk) begins in May and ends in the middle of September; the navigation on Oussouri River continues from the middle of April to the middle of October; the steamers, after the winter stay, start about the middle of May from Nicolaicvsk, the estuary of the Amour. A good navigable year has only 170 days. The navigation in the lower and middle part of the Amour (about 1,300 miles), up to Blagoveshchensk, is quite convenient and open during the whole period. From Bagloveshchensk to Pokvovska the navigation on Amour and further to Sretensk the navigation on its tributary, Shilka, is not so easy, and sometimes in low water must be suspended entirely, the depth in some spots being only 2½ feet. The commercial fleet on the Amour consists of 100 steamers with engines of 4,500 indicated horse-power, and about 200 barges with a tonnage of 17000.

This number of steamers and barges being not sufficient for the transportation of the materials destined for the construction of Siberian railroad, the government has ordered two side-paddle tug steamers for the Amour: one of 600 indicated horse-power and another 900 indicated horse-power, and seven steel barges, each with a carrying capacity of 400 tons. In this manneronly the transportation of materials and the terms of construction of the Siberian Railroad can be obtained.

GENERAL REMARKS.

The above statements show that in the years 1895 and 1896 the construction of the Great Siberian Railroad was carried on with an uncompared energy, as is obvious from the following figures, showing the progress of tracklaying:

The length of track at the close of 1893 was	257 miles.
" " " " 1894 was	885 "
" " " " 1895 was	1,808 "
" " " " 1896 was	1,990 "

If we compare the latter figure with the total length of the Great Siberian Railroad from Chelabinsk to Vladivostok, 4,507 miles, we see that the track is already laid on nearly the half of the main Siberian Railroad. On the other side, comparing the length of the continuous railroads, old and new ones, opened for traffic from St. Petersburg to Krasnoiarsk, 3,670 miles, with the total distance from St. Petersburg to Vladivostok, about 6,232 miles, we find that the half of this distance can already be traveled by rail.

A. ZDZARSKI.

Thirty years ago the B. & O. bought steel rails in England at a cost of $112 per ton in gold. Some of this rail is still in use on short branches and is in marvelously good condition. It is pear-shaped and was intended for use with wooden splices.

Communications.

Railroad Testing Bureaus.

AUGUST 6, 1897.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

Before I had read the article in the August number of your paper on the subject of "Railroad Testing Bureaus" I had made a memorandum to write you with the request that you take up this question of laboratories for the purpose of ventilating it a little. The subject will probably be discussed at the convention next year, but I cannot wait to express my disapproval of any plan looking to the entering of such a field by the Master Mechanics' Association, and cannot believe the Master Car Builders will seriously consider the idea of going so far out of their way. Before I had a laboratory in my department I found it very convenient and entirely satisfactory to have testing done by one of the regular testing bureaus, and I am not sure now that it would not be money in our pockets to continue in that way. I think that the railway associations have no business to establish laboratories for routine work. The various testing bureaus or private concerns engaged in this business can do it more cheaply and more satisfactorily for such roads as cannot maintain laboratories of their own. Regarding the special work for which you conclude a laboratory or laboratories established at central points would be feasible I would say that the idea seemed to me to be a good one if there is work enough to keep such a laboratory going. I think, however, that there should be only one such laboratory in the country maintained by the association, as there would certainly not be enough work to keep more than one busy. Such a laboratory should include a dynamometer car, a stationary testing plant and facilities for making such tests as those by the committee on best metal for brakeshoes. Such a laboratory might be started in a modest way and added to as the necessities appear. I heartily approve of this part of the idea if it is not overdone.

MASTER MECHANIC.

Lubrication of Locomotive Cylinders.

RIO CLARO, BRAZIL, July 8, 1897.

EDITOR OF THE AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

Will you allow me to say that I cannot agree with the writer of the article on lubrication of locomotive cylinders in your June number, either as to the cause of the trouble now being experienced or the remedy therefor? I do not believe that condensed steam accumulates in the oil pipes at any time if the instructions of the lubricator companies are followed in giving these pipes a constant descent from lubricator to steam-chests. Water will always run down hill, and there is nothing to prevent these pipes draining themselves after the pressure has equalized, if there are no sags. This, however, is what I believe *does* take place.

After the drops of oil have passed up through the water in sight feed glasses they are blown into the oil pipes by the steam through the pin holes in the choke plugs, and by this process the oil is thoroughly atomized. If the throttle is closed this steam expands after passing the choke plugs, and makes a sufficient volume to create a current strong enough to carry this oil through to the steam chests in its atomized state. Now, if the throttle is opened, the pressure from the steam chests rushes up into these pipes, forcing this expanded and oil-laden steam before it until the pressure is equalized, and the pipes are swept clean of oil for a considerable distance. After the pressure has equalized, the current again sets toward the steam chests. But the small amount of steam that can pass through the pin hole in the choke plugs, not being allowed to increase its volume by expansion as before, in consequence of the pressure from below, does not make enough current to carry the oil along in its atomized state; instead of which, this oil adheres to the surface of the pipes, then collects in drops, and finally after a considerable time accumulates in a sufficient quantity to run to the steam chests by gravity, assisted somewhat of course by the feeble current in pipes. Any reduction of pressure in the steam chests causes the steam in pipes to expand and rush out, bringing the accumulated oil with it, and then we must wait for it to collect again as before. This, of course, gives a very irregular feed to valves while the engine is working steam.

Enlarging the pipes would, I should think, aggravate the evil, as it would present more surface for the oil to collect upon, and also further decrease the velocity of the current. If any change is to be made, I think the pipes should be made smaller. The devices spoken of as being applied by the lubricator manufacturers, to automatically let a larger volume of steam into the pipes, at or near the lubricator, would seem to me to be the best way out of the trouble, although, as is stated, this makes a complication that should be avoided if possible. If an engine were left standing with closed cylinder cocks, sufficient pressure might accumulate in the steam chests to open these automatic valves and cause the engine to move off at an awkward time. The question would seem to be, whether the evils now complained of are grave enough to justify this complication and its attendant danger.

I cannot see how anything would be gained by using the falling drop lubricator. There is no difficulty now in getting the oil into the pipes; the trouble is in getting it through them. The distance which a locomotive lubricator must be situated from the point where oil is required is such, that gravity alone cannot be depended on to do this satisfactorily, when so small a quantity is to be fed at a time. I have, no doubt, however, that lubricator manufacturers, now that their attention has been so generally called to this difficulty, will meet and overcome it in the best possible manner.

C. L. DUNBAR.

[A great deal may be said upon this subject, but we are disposed to await the results of some careful experiments now being conducted by the officers of a large road before putting forth any more statements which are not based upon absolute knowledge of what goes on inside the pipes of locomotive lubricator systems. We believe our correspondent to be wrong, but are unable to prove it now. When the tests referred to are completed more will be said upon the subject.—EDITOR.]

The Strong Balanced Locomotive.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

Again the old subject of the hammer blow is brought to our notice; this time in a slightly different light. At one time the "hammer blow fiend" got to be such a nuisance that threats of annihilation seem to have prevented the term being used in connection with recent tests at Purdue University, but notwithstanding the idea still remains like the fellow who thought "damn" if he could not say it. There is not a particle of doubt but that the Strong locomotive can be balanced both vertically and horizontally, but we do not think that the game is worth the candle, in the fact that not only is the vital machinery of a locomotive doubled but the very uncertain crank angles are also introduced. Professor Goss' tests show what every engineer knew before would be the result of this arrangement, that the wheels would turn smoothly at all speeds and if this is the whole intent of the builders; the locomotive will undoubtedly be a success in that particular, as there would be no excess balance in the wheels and probably no tendency to "nose" on the part of the engine.

Mr. Strong's letter in the *Railroad Gazette*, dated Aug. 9, says in one place: "The heavy pistons and weight of the reciprocating parts make the use and ownership of such engines too expensive." The remedy that is proposed in this engine seems to me like an antidote for a poison, instead of getting down to bed rock and eliminating the poison altogether. While it is true that the inertia of one piston with its piston rod, crosshead and connecting rod moving in one direction, is balanced and counterbalanced by its fellow piston, piston rod, crosshead and connecting rod moving in the opposite direction, yet it is nowise true that the inertia of the parts has been eliminated; in fact, not only do we have the inertia of one set of piston and attachments, but we have double the effects caused by its fellow pisston and attachments. It is true that the individual parts can be made possibly lighter than when the same power is obtained from a single piston, but there will certainly be more weight in the two sets of pistons, etc., than when the same power is doubled with one piston, and while the thrust of the inertia is distributed over a greater amount of bearing surface, yet it is still there, and will make itself felt in wear on journals, bearings, etc. In June, 1896, the undersigned presented a paper on "Locomotive Counterbalancing," before the

Association of Engineers of Virginia, in which he recommended that the amount of unbalanced reciprocating weight for one side of the engine be taken at $\frac{1}{360}$ of the whole weight of the engine in working order. About the same time the Committee of the Master Mechanics' Association recommended $\frac{1}{400}$ for this value, but Mr. E. M. Herr, the Chairman of that Committee since stated that he believed $\frac{1}{300}$ was just as good as $\frac{1}{400}$, and judging from the very steady and easy riding of a locomotive recently redesigned and whose unbalanced reciprocating weight is $\frac{1}{312}$ of the total weight of the engine, it seems to be evident that the excess balance may, with proper designing, be gotten down to a very small figure. The engine referred to has 20-inch cylinders, 68-inch driving wheels and operates with 180 pounds steam pressure, from which it will be seen that a strong piston and connection is necessary, but for this engine we have the following reciprocating weights:

1 Piston and rod	308 pounds.
1 Crosshead	183 "
48 per cent. of main rod	205 "
Total	696 "

This, we think, is very light for this size of engine. The counter-balances in this engine appear to the eye to be very light and, in fact, the pressure in a vertical direction due to excess balance in the wheels, amounts to but 4,000 pounds per wheel at a speed of 68 miles per hour, and as the load on each wheel (not axle) averages 16,000 pounds, it will be seen that the effect due to the excess balance is very small. It is true that there are many engines running in which the effect of the excess balance at high speeds would be as great as the static load on the wheel, but we must file a disclaimer that these engines should be considered a good design as far as this detail is concerned.

From the above facts we believe that a two-cylinder engine, simple or compound, can be so designed that the reciprocating weights and excess balance in the wheels will in no wise be detrimental to the operation of the engine or the track, and without necessitating the extra care which double pistons, crossheads, guides, connecting rods and cranks is sure to result in, and we are confident that this opinion will be sustained by 99 per cent. of the practical railroad men in this country.

Only a few years since, one of our oldest authorities on locomotives recommended a pendulum motion from the crosshead by which a weight equal to the piston, etc., should be swung in the opposite direction by a system of levers, and while this was much laughed at and discussed at the time, yet we believe in the long run it would be preferable to doubling up our pistons, crossheads and connecting rods.

G. R. HENDERSON.

ROANOKE, VA., Aug. 20, 1897.

Why Automatic Road Crossing Signaling Apparatus Fails.

BY V. K. SPICER, MEM. AM. SOC. C. E.

The question of protection to people and vehicles at crossings of highways and railroads has occupied much thought, and many devices for the purpose have been employed with greater or less success. Gates operated by men stationed at the crossings are most frequently used to afford such protection.

A man armed with a flag, or lantern, having authority to arrest the progress of passengers, even if he is vigilant, can afford but limited protection. Supplemented by the most effective gates, his actual duties are increased, his attention distracted and his ideas of responsibility reduced, from the fact the gates under his manipulation are intended to warn against and prevent passage across the tracks. It is practically impossible to impose and operate any sort of physical barrier against the foolhardy passenger that will be effective and economical.

In order that ample warning of the approach of trains shall be given, not only to a crossing watchman when one is employed, but to all who may be in the vicinity of the crossing, visible and audible indications must be exhibited at the proper time, and continue in evidence until the passage across the tracks is again safely open. Without such warnings, a watchman has no accurate knowledge of the approach of trains during foggy or stormy weather, or when his sight or hearing is obscured. With a thoroughly reliable arrangement of this sort, the best possible protection can be offered to the public at ordinary highway crossings.

"Self preservation is the first law of nature," and a warning of danger, given in ample time, in a way which will allow the faculties to act without restraint, will be more effective than anything else to prevent accidents of every sort. Since the human being only is capable of fine reasoning and it is for him that the warning is offered, a sign and a sound—a visible and audible signal—produced at the right time and place, cannot but be effective for the purpose, and this gives the automatic signal its strong recommendations for crossing protection.

This indication, however, must be absolutely reliable; not only must it never fail to act for the purpose for which it is designed, but it must never give a false alarm. The cry of "Wolf, Wolf!" when there is no wolf, invariably leads to despising the animal. A crossing alarm bell that rings for any other cause than that for which it is intended is a greater menace than no bell at all. Curiosity on the part of the average passenger leads him to observe any irregularities. Arriving at the crossing and hearing the bell ringing he naturally stops and waits for the supposed train to pass. Finding that there is no train he will make some disparaging remarks and proceed on to the crossing, keeping an eye on the bell rather than on the track. On the other hand a bell that fails to ring at the proper time serves to cast discredit on the system, so that the passenger is taught to take chances and the danger is increased.

Of the many automatic devices made and applied for the protection of highway crossings at grade, there are some which are as nearly perfect as it is possible to desire. That they usually fail to give satisfactory results is not attributable to any inherent imperfections of the design or construction, but almost entirely to the fact that they are not maintained with the necessary amount of intelligence and care, after they have been applied and turned over to the railroads. In order that a watch shall keep perfect time, it must be regularly wound. It must be inspected, cleaned and regulated. Most railroad companies retain a regular watch inspector and require their employees to not only possess a standard watch, but to have it examined at stated periods and a certificate of inspection secured. Only under similar conditions can accuracy in any department of a railroad be insured. The signals, however, seldom have a corresponding degree of care. Telegraph systems are efficient at the expense of a head of the department with his numerous assistants who are all expert in their particular lines. It is not reasonable to expect that an engine runner can despatch trains from a telegraph instrument any more than that a lineman should be able to repair a locomotive; and yet it is common to find telegraph men held responsible for signals, which is equally inappropriate.

If the telegraph department is employed and the duties assigned to a certain number of men, almost always the fewest that can possibly be made to do the work, and they are expert in their particular vocations, the imposition of special, additional duties on these men, especially if no extra compensation is given, must result in neglect to some of them. A lineman has the care and repair of a certain section of pole line and the instruments with their accessories. He must be on the constant look out for "trouble," which may occur at any moment on any part of the line. His first duty is to go to that point at once. The line is long, the stations many and many hours are necessarily spent in traveling. He is human and is naturally eager to get home at the end of the day. Trains are not frequent, and he is obliged to catch the most convenient ones for his purpose. This gives him a limited time in which to examine and repair the apparatus under his charge, and if he does not succeed in doing so at the right time, he usually fixes it up in "good-enough-for-the-present" shape and leaves it until the next day. Meanwhile, perhaps a storm causes damage in another place, and he is obliged to go there at once, and the incomplete work waits. The common practice among railroad companies of putting all sorts of apparatus involving electrical devices under the care of the telegraph department has not only overburdened this department, but has resulted, with but few exceptions, very unsatisfactorily. Bells and signals for the protection of highway crossings, where these are automatic, involve electrical devices in their construction. They are not necessarily complicated and need not demand particularly expert care. They must, however, be regularly inspected by a man competent to understand their requirements and they must be kept in repair and in correct adjustment, just as a watch, or a locomotive, or any other apparatus must be, if satisfactory results are to be attained. Unless this can be done, there is infinitely greater safety to the public and saving of money to the railroads, in the ordinary cheap signboard which announces to all who may read: "Look out for the engine when the bell rings."

Railroad companies generally go to great expense to inclose their rights of way. They have encouraged inventors in their efforts to perfect apparatus for these purposes by offering facilities and opportunities for testing their inventions in practical service on the lines, holding out the assurance that, if satisfactory in operation and price, they would purchase. The weak point in almost every invention has been the lack of knowledge, on the part of the inventors, of the circumstances existing on the railroads. Where these have been successfully met, the failures to

the satisfactory operation of the devices have been due almost entirely to the fact that the railroad companies have not employed proper men to maintain them. The word "automatic" attached to signaling apparatus seems to imply to the average railroad man that it is self-sustaining as well as self-operating. This is a most serious mistake.

For example, consider the automatic rail circuit system in connection with block signaling, operating highway crossing bells, switch and bridge locks, locks on interlocking levers and a variety of other devices. The track circuit, in order that it shall be effectively established, demands that every rail joint shall be bonded with wires; that the block sections shall be separated, electrically, from their neighboring block sections by insulated joints; that the batteries shall be set up and connected by substantial conductors properly protected and connected to the rails; that the relay or electrical instruments shall be protected from harm and interference, in order that they shall be operative. The rails, joints, ties and roadbed are kept in condition for traffic by a gang of men whose chief duty this is. It is customary to require these men to look after the track attachments of signals also. They are familiar with ordinary work of the track and have more or less of a standard by which to work. They know when a rail joint needs lining, tightening or renewing. They know where, when and how spikes must be driven. Their duties require that the track shall be in good condition for the passage of trains, clearing the roadbeds of weeds, dressing ballast, renewing ties and many other incidental matters are left for such times as they are not thus employed. Bond wires, track insulations, connections to batteries and similar attachments, where such exist on a section, are constantly passing under their eyes. They have an indistinct idea of their purpose and importance and have received orders to care for them. The apparent mystery of the thing stands in the way of intelligently doing this and, together with the weeds, ballast and other things they, like the telegraph men, put off the signals for a more convenient time until matters have long gone wrong. They have their regular duties and are subject to special call orders. As a rule they are the least intelligent, worst paid employees and it is unreasonable to expect them to understand the simplest details of signaling apparatus and the accessories entering into the track department.

The various parts of signal apparatus are simple in themselves, but they each form a link in a chain, and one defective factor spoils the whole. The automatic signal never fails without reason, and a broken link due to neglect is usually the reason. The remedy lies in treating the subject with the same degree of care and watchfulness as is devoted to the other important factors which go to make up a safe railroad. Let us ask how often locomotives are inspected, and how about bridges and rock cuts along the line? We are at present limiting ourselves to crossing signal apparatus, which is but a small part of the whole department of automatic signaling, but very serious accidents may occur at crossings, and a special reason for the most careful maintenance of such devices lies in the fact that it is very difficult to prove that the apparatus worked properly at the time of an accident. Frequent inspection and constant care are the price to be paid for the best evidence that is to be had that the instruments were doing their duty, and this will also tend to render occasions for such evidence less frequent.

Staybolts Broken and Partially Broken.

Among the noon-hour topical discussions at the recent Master Mechanics' convention was one upon Broken Staybolts, which was introduced by Mr. T. A. Lawes, Superintendent of Motive Power of the C. & E. I. Railroad with the following remarks, which form the basis of another article upon the same subject presented elsewhere in this issue:

Under the presumption that you will readily grant me permission to qualify the phrase, I shall be pleased to present to you a few thoughts on the subject of "Partially Broken Staybolts," which, in my opinion, is a topic of much greater importance, since partially broken staybolts are the more difficult to detect. In fact, so far as my investigation goes, they are never detected under the old methods, and must be regarded with suspicion.

For some years hollow staybolts and drilled staybolts have been used to a limited extent, but for some reason—or no reason—neither one has been put into general use, although, as I believe, the protection afforded is invaluable.

To satisfy myself as to an inspector's ability to detect broken and partially broken staybolts, I have had the staybolts in 13 engines drilled during the past year. The plan adopted was to have the inspector locate all the broken staybolts he could find, after which the staybolts in the firebox were drilled, including those marked by the inspector as broken. In the first firebox tested in this manner the inspector found 39 broken staybolts. After drilling and testing under water pressure these were all found broken—and in addition to these we found 59 others broken which the inspector was unable to detect by the hammer test. This surprising result led me to examine the broken staybolts critically, and I found that those detected by the hammer test were broken entirely off, while those found by drilling holes in the ends were only partially broken off.

After testing the stay-bolts in 12 fireboxes and finding the ratio of broken staybolts and partially broken staybolts about the same as in the first firebox tested, I concluded to try the method of testing under boiler pressure, and having a helper hold on while the inspector gave the hammer test, but with no better results.

I desire now to direct your particular attention to the 13th and last firebox tested for broken and partially broken staybolts by the two methods. I consider it the most severe comparative test of all, from the fact that three inspectors in turn did their level best to locate broken and partially broken staybolts by the hammer test, they having been informed that the staybolts were to be drilled after they were through with their inspection. They were given all the time they required to make a careful and accurate inspection. The result was that the hammer test located four broken staybolts and the drilling test discovered 46 partially broken.

A careful record of the broken and partially broken bolts detected in 13 engines shows that 440 were discovered by the hammer test, and 619 by the drilling test.

To me these facts are conclusive evidence that partially broken staybolts cannot be detected by the hammer test, and I believe a great risk is run by either not drilling the ends or not using hollow staybolts, and that either of these precautions will prevent many boiler explosions with the usual verdict of "Cause of explosion unknown."

There have been more boiler explosions in recent years caused by broken staybolts than ever before. I attribute this to the fact that a much higher pressure is carried. Too great precaution cannot be taken to prevent loss of life and destruction of property, and my experience leads me to recommend that every staybolt used should be either hollow or drilled, making it self-detecting.

The expense of the precautions here recommended should not stand in the way of preventing boiler explosions due to defective staybolts, as the cost for drilling is only about $3.75 for a firebox containing 900 staybolts. I figure that the cost is only an apparent one.

For example: If the 619 partially broken staybolts had not been drilled and tested in the 13 fireboxes referred to above, these partially broken staybolts in time would have become broken staybolts, and the engines containing them would have to be laid up—possibly when needed badly—for the removal of broken staybolts, which would have necessitated the removal of jackets, air brakes, pumps, frame angle iron and other parts covering the staybolts, thus causing an additional expense over that, if properly attended to in the shop while undergoing repairs.

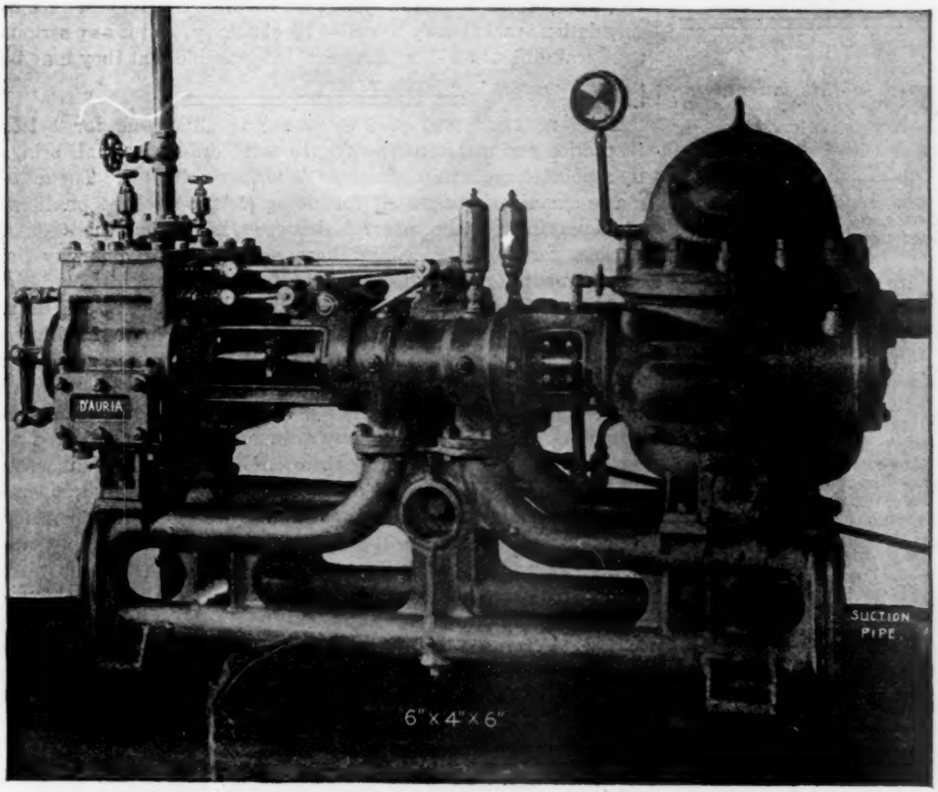
It is my practice to turn engines out of shop with staybolts beyond suspicion, and I find that I have no trouble with them afterward. I recommend to such members of the association as do not use hollow or drilled staybolts, that they drill the staybolts in a few fireboxes as described and keep a record of the number found by the hammer test and by drilling them, and I am sure that they will be surprised at the results.

The d'Auria Pumping Engine.

The problem of working steam pumps which are not fitted with heavy flywheels in a way permitting of using steam expansively has proved itself a troublesome one and the new pump shown in the accompanying engraving is brought to our attention with strong claims for the economical use of steam. The design is due to Mr. Luigi d'Auria and is described in a circular by the d'Auria Pumping Engine Co., from which the following information is taken:

Cut-off valves are used to secure the expansion of the steam in both simple and compound types. The expansion is made possible by an exceedingly simple and ingenious compensating device which adds nothing to the working parts of the pump that is at all likely to give trouble in operation. This device consists mainly of a liquid column contained in a closed loop of pipe extending from the ends of a chamber in which a piston or plunger is fitted and carried by the same rod upon which the steam piston and the

pump plunger are attached; so that when the latter are set in motion by the action of the steam, the liquid column is forced to reciprocate with them. This liquid column then acts as a balance wheel, controlling the speed of the piston, and producing a smoothness of action stated to be comparable only with that of the best crank and fly-wheel pumping engines. Pendulum-like the reciprocating parts are brought to rest by the gradual expending of their energy while doing useful work. Any excess of energy at the end of the stroke is safely absorbed by steam cushioning, lengthing the stroke somewhat, and filling the clearance space with steam of high pressure ready to do work in the return stroke. A very simple by-pass, made in the piston or plunger which reciprocates the liquid column, absolutely prevents the steam piston from striking against the cylinder-head. In case of a sudden release of pressure upon the pump, caused by a break in the main, a safety device is provided which throttles the liquid column of the compensating device and transforms the latter into a sort of cataract, checking at once the speed of the engine; and as the safety attachment closes the steam throttle at the same time, the engine is brought to rest before it can possibly reach the end of the stroke. Of course, this attachment is only required in large pumping engines. In smaller ones, the engine takes care of itself without it, the steam cushioning and by-pass being quite sufficient to prevent striking under any circumstances. The pipe containing the compensating and controlling liquid column is so designed as to form a bed plate for the engine and pump. With this bed plate it is said that the pumping engine can be placed on any floor and run without being fastened to it. The admission and cut-off valves are plain slides connected to their stems and rock shafts, without lost motion.



The d'Auria Pumping Engine.

The circular is authority for the statement that the engine shown in the engraving, a 6 by 4 by 6-inch non-condensing engine gave a duty of 26,200,000 foot pounds, corresponding to 76.6 pounds of steam per pump horse power per hour, the pump developing 6.87 horse power. This result with such a small pump is remarkable, especially when it is considered that the pump was new when tested, not having been under steam over one day altogether. The claim is based upon this test that a simple, seven horse power d'Auria pumping engine uses steam as economically as an 80 horse power compound pumping engine of the ordinary duplex type. The construction of a larger equipment is now under way, and as the saving of steam means a smaller investment in boiler plant as well as in fuel, the new design appears to be what hydraulic engineers have been in search of for years.

Rope Driving.

At a recent meeting of the Birmingham Association of Mechanical Engineers (England), Mr. Geo. H. Kenyon, of Dukinfield, read a paper on "Ropes and Rope Driving." Mr. Kenyon said that for all practical purposes rope transmission may be regarded as positive, all things considered, and in making calculations for speeds the supposition that slipping and consequent diminution of speed must of necessity enter into the equation may be dismissed as scarcely worth consideration. The elasticity of rope driving was of supreme importance; the ropes themselves were very sensitive to any irregularity, and acted as a buffer between the initial and ultimate power, making back lashing (the bane of gear driving) an unknown quantity. There were many points to be observed and enforced before the high-tide mark of efficiency may be reached. First and foremost was the construction of the groove, the most effective style being that with straight sides resting at an angle of about 40 per cent., and of sufficient depth to prevent the rope reaching the bottom or the curve with which the rope terminates. On no account should grooves with curved sides be used, as it is impossible for ropes to bed themselves, and they become restless and roll round in the attempt. It is generally acknowledged that ropes should never be run upon pulleys of less than 30 times their own diameter. Although good cotton ropes will coil in considerably less compass, yet it is always wise not to go below this limit, and err, if at all, in the direction of large-size pulleys, as the repeated effort of compression and extension produces what is well expressed as "fatigue" material when the elasticity is worked out. The best results may be anticipated when the smallest pulley is 50 times the diameter of the rope. In his opinion it was always advisable to consult with a thoroughly practical engineer respecting power transmission before submitting any scheme for the erection of electrical installations. Whatever new material may be discovered in the future—and several new fibres had recently been experimented with—he knew of none which even approached, let alone superseded, cotton for the purpose of rope driving; for it was strong, durable and pliant, yielding readily to the shape of both pulley and groove, and quickly recovering its normal tension after every wrench and strain. He submitted a sample of cotton rope that had been running for 11 years at the rate of 20 hours per day, and which was as good as ever.

The Railway Signaling Club.

The next regular meeting of the Railway Signaling Club will be held at the Grand Union Hotel in New York City on Sept. 14, 1897, at 4 o'clock P. M. The discussion of a paper by Mr. H. M. Sperry, entitled "Some Signal Problems" will be held. A committee report on Battery Tests will be read; and a paper by Mr. Charles Hansel on "A Moral and Physical Agent in Safe Railway Travel" will be presented.

As this meeting is the first one to be held outside of Chicago, it should be the earnest desire of every member to make it a success. The Lehigh Valley Railroad has extended an invitation to the club to take a trip to Easton from New York and return, on a special car, which has been accepted by the Executive Committee on behalf of the club, and arrangements have been made to insure an interesting and profitable meeting.

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It is with pleasure that we announce elsewhere in this issue that the Railway Signaling Club will hold its next meeting in New York City. Since the meetings have hitherto been held in Chicago, it was impossible for more than a few of the members to take part in the discussions, and to give the Eastern members an opportunity to obtain direct benefits from the organization is an important step which will tend to make the club more truly a national affair. This movement of the signal engineers to form an association has been a modest one. It deserves success, and it is to be hoped that it will receive encouragement and support from managing officials.

In another column the counterbalance tests of the balanced compound locomotive are very briefly described. The complete report of the tests has just been received from Mr. Geo. S. Morison, too late for a satisfactory examination of the data and the conclusions drawn from them to admit of an intelligent criticism. The tests showed conclusively that the counterbalancing is in every respect satisfactory. It is, in fact, a perfectly balanced engine, and the efficiency trials brought out a number of highly interesting points concerning the engine and boilers. The latter gave good evaporative performance, remarkable steam capacity and a high ratio of water evaporated to coal burned. The engine did not do as well as the boiler, but no guesses will be offered at this time as to the reasons. The results and their import will be discussed next month.

There has been much controversy as to the best methods of applying electric traction to the movement of trains, and for several years the use of motor cars and trailers has had the approval of practice. Mr. Frank J. Sprague, whose experience in electrical engineering renders his views worthy of special attention, has developed a system of multiple unit control, which is now ready for application upon the South Side Elevated Railroad of Chicago, as is noted elsewhere in this issue. By this system each car has its own motors, and the controlling devices are so arranged as to permit of operating all of the motors from the platform of any car in the train. It is evident this will necessitate the use of small motors and rather complicated controlling devices, but the tractive weight will be distributed in a manner almost ideal. There is an advantage to be had from the better efficiency of larger motors, but the benefit to be derived from having each car independently supplied with power will be likely to outweigh the losses from the subdivision of the power. The application of this system is likely to cause much discussion, and it is well that the experiment is to be tried on a scale large enough to present positive data, from which to judge of its merits. Its best recommendation is what may be called its elasticity, and if any serious practical difficulties should appear, it is possible that they may be overcome.

The argument presented elsewhere in this issue for better inspection and maintenance of automatic crossing signals brings up a point of great importance to American railroads. The automatic signal, whether used for giving warning to the public or of maintaining space intervals between trains, has the best of reasons for its existence, and there are special reasons why the employment of automatic apparatus for these purposes should be considered good practice. We will not discuss these at this time, but will emphasize Mr. Spicer's contention for more intelligent and appropriate care. Automatic signals do not sleep, get drunk or neglect their duty, and in these respects they give better and more reliable service than men do. They require considerable attention because of the many influences which, if allowed to work long enough, will throw them out of adjustment, but when such attention is given they are found to be satisfactory in operation and are cheaper than manual signals where for the operation of the latter special men must be provided. Some day undoubtedly this matter of the necessity of looking after automatic signals will be appreciated. It is true that this is not the case today on a large number of roads, and signal engineers should see to it that the importance of this branch of their work is not lost sight of, for it is better to have no signal at all than to have a poor one, the operation of which is doubtful.

A prominent engineer, who has a world wide reputation as a designer of high-grade pumping engines, points out a glaring inconsistency with regard to the class of work upon which he is engaged. He wonders why the greatest possible care should be given to the design and construction of a pumping engine and its boiler plant, no expense being spared to reduce the wastes of operation to the lowest terms, and then, boiler feed pumps, that use nearly as much steam as the main engines, should be selected to do only a small fraction of the work. The usual form of boiler feed pump is proverbially wasteful in its consumption of steam, and, to be consistent, a high-grade pump should be employed for this purpose. This general criticism is not to be confined to pumping equipment. It may be asked whether marine practice is what it should be as to auxiliaries. For instance, a battleship built last year has a total horse-power of 12,280 in its main engines and in 146 auxiliary engines 2,800 additional horse-power is provided. The main engines run with an expenditure of 1.82 pounds coal of per horse-power per hour. What the consumption of coal in the auxiliary engines, constituting 22 per cent. of the power of the propelling engines would be, is an interesting question and one which is worthy of attention. Recent reports on the working of compressed air in one of our warships are interesting and suggestive in this connection.

COMPRESSED-AIR LOCOMOTIVES.

Elsewhere in this issue under the caption "Compressed-Air Traction," some figures are presented giving the mileage of the two street cars which are fitted with Hardie motors and are now running on the 125th street line in New York City, and in the May issue of the current volume will be found a statement of the cost of operating them. In our issue of March of the current volume will be found an illustrated description of the compressed-air locomotive, which has for some time been awaiting its trial upon the New York elevated railroads. It has been tried and found capable of doing the required work. Trials of compressed-air motors have not always been attended with satisfactory results, but our readers will be interested to know that the motors mentioned and also the compressed-air locomotive have given such good results as to warrant the statement that as far as furnishing the power is concerned they meet all requirements. The only question remaining to be decided is that of cost of operation as compared with other systems for similar work, and the flexibility of compressed air as applied to long-distance lines. This type of motor is somewhat handicapped as compared with electricity by the necessity for charging the reservoirs. But as this can be done with the high pressures used in the Hardie system without greater loss of time than is now experienced in filling locomotive tanks with water, no trouble is anticipated from this source. The question of cost can only be settled by experience and that already gained with the street car motors must be considered promising.

Some of the sources of loss in electric traction systems are noted elsewhere in this issue and while the efficiency of compressed air from the compressor to the locomotive cylinders is not by any means 100 per cent. it is doubtful whether the losses are more than those of electrical plants. The absence of refined experiments in this connection makes it impossible to state at present what the efficiency is, but it is not believed by the writer to be below that of electric installation as now used in every-day service.

A compressed-air system equipped with a liberal amount of storage capacity for the air compressed to the charging pressure enjoys an important theoretical advantage over an electric plant in that the engines may be adapted to a certain steady load and may be kept running upon that load nearly all of the time and in this way considerable flucuations in the demand for the air on the locomotives may be accommodated without running the power generators at either an overload or an underload. The effect this will have upon the economy of operation cannot now be stated in figures. One thing, however, seems to be proven that the noiselessness of operation, the freedom from obnoxious gases, smoke and cinders and the ease with which the compressed air is handled together constitute strong claims to attention and if the financial side of the question is as satisfactory there is a large field for the application of compressed air to tractive purposes. The opportunity for comparing the air locomotive with steam and electric systems is at hand and the figures will be looked for with great interest.

LOCOMOTIVE IMPROVEMENT.

For the present steam is the main starting point in all general applications of power in transportation. Whatever system of distribution is used steam is now the prime mover, and because of this, improvements in the application of the steam engine are most important. Of all types of steam engines the locomotive is the most difficult to improve, because of certain well understood limitations, and in other lines of steam engineering vastly greater progress has been made in the direction of efficiency.

It is not now at all difficult to build mill engines that will produce a horse-power for the consumption of 13 pounds of water per hour, and F. W. Dean says that it is as easy to produce such an engine now as it was to build one to consume 16 pounds only a few years ago. The basis for this improvement is interesting. The causes may be stated to consist of the use of steam jackets, compounding, reheating and higher steam pressures. These are all old ideas, and they are now being combined to assist in improved efficiency. Marine practice has shown similar strides, and the locomotive seems to be slower, although it must be credited with some advances in spite of the discouraging handicaps.

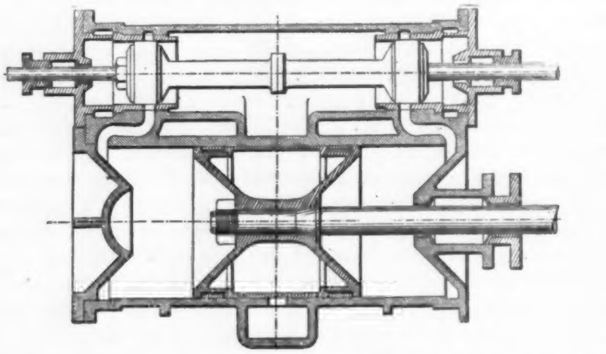
The list of subjects for the next convention of the Master Mechanics' Association includes three which may be considered as promising lines for discussion and development; they are : tonnage rating, boiler and cylinder insulation and higher steam pressures. Among the means suggested for improving locomotive performance beside those already mentioned are: Compounding, the use of lower piston speeds, larger heating surfaces, less forcing of the boilers, the heating of feed water, hot jackets for cylinders, superheating the steam and improved valve gears. Some of these must be said to be so difficult to perfect and employ, on account of complications which they involve, as to be practically beyond consideration.

The compound locomotive was stated by the President of the Master Mechanics' Association at the last convention to be still in the balance, but there were certain signs that it was gaining friends. This view is believed to be correct. The compound is gaining the confidence of engineers, and we believe justly so. More confidence will probably be placed in this type as improvements in methods of keeping fuel records are introduced. The effects of changes in the design of compounds will be better understood after the type has been studied more thoroughly upon testing plants. The chief objection to this type has been that of the additional complication involved in the design. But with recent practice the compound is very little more complicated than the simple engine, and there is even a danger of going too far in sacrificing good performance to simplicity in construction. The best marine and mill engines of to-day are far more complicated than were those of 25 years ago, but they will do more work for the same money. This applies equally well in the case of the air-brake, which is not to be considered a simple apparatus, when compared with the hand-brake. In neither of these cases is the complexity thought to be disadvantageous, and even if more cylinders and more complex valve gear are required upon locomotives in order to make them capable of doing more work for the same weight and the same expenditure of fuel the complications will eventually be considered in the same light as they are in marine and mill practice.

There are ways in which locomotives may be improved without any radical changes in design, and these are the ones which are naturally the most practical, and are to be considered as lying to one's hand. The greatest advances in the other types of engines have been in the direction of improving the action of the steam in the cylinders and reducing the wasteful interchange of heat between the steam and the metal. It is this effect that gives superheating its greatest advantage. The same applies to steam jacketing and to compounding, and to get this effect to as great an extent as possible without any of these additions is a worthy object. The jacketing of the boiler, firebox and cylinders with non-conducting coatings is one of the first improvements to suggest. No other type of steam engine is so much exposed to the cooling effects of the atmosphere as is the locomotive, and the results are easily seen in the difference between summer and winter performance sheets. Another easily applied protection against condensation losses is the separation of the steam and exhaust passages as far as possible in the cylinder and saddle castings. The steam coming through a steam pipe which is close to an exhaust passage in the same casting must be cooled and condensed to a considerable extent before it reaches the cylinder, and steam containing 5 per cent. of moisture requires five per cent. more water per horse-power per hour. It is the condensation of the steam in entering the cylinder through long passages which have been previously cooled by the exhaust steam that seems to be the most important source of loss. This is probably even more important than the condensation caused by the cylinder walls. Piston valves make it possible to use short steam passages, and this is an item of importance. Mr. L. J. Todd in a recent issue of *The Engineer* describes an interesting plan which he calls "dual exhaust," that may show itself to be adapted to reduce the effect of the cool passages, and it is

interesting in this connection, although its employment can not be advocated without further experience.

The scheme consists in using a long piston which, when nearly at the ends of its stroke, uncovers a series of exhaust ports cut through the cylinder walls and communicating with the exhaust port direct. The bulk of the steam passes out of the cylinder in this way and the exhaust closure may be regulated by means of what is called the preliminary passage, which is the ordinary valve passage. Mr. Todd makes strong claims for this system and he appears to have excellent grounds for them. He uses ordinary valve motions with piston valves and gives exhaust lap to the valve in order to delay the opening of the regular exhaust passage when running at short cut-off. In this way the card is given a larger area and the mean effective pressure for a given cut-off and boiler pressure is raised and at the same time less



steam is used per horse-power per hour. The dual exhaust ports are opened at a fixed point near the end of the stroke, and there is no trouble with choking the cylinder with steam when running fast at short cut-off. It is obvious also that the clearance spaces may be materially reduced by this plan. The piston is increased in length, and so also is the cylinder, but these are not serious objections, and the beauty of the idea is that not a single extra moving part is required. Further experiments will undoubtedly be made, and the results already attained warrant giving attention to the suggested improvement. To show the simplicity of the dual exhaust we reproduce an engraving from the article referred to.

It is believed that condensation of steam in cylinders and steam passages is not considered as being nearly as serious as it really is and it is also believed that great improvements may be made without resorting to steam or hot gas jacketing, or any other complication. The exacting requirements and the rigid limitations in the design of locomotives make it seem all the more necessary to make the most of such factors as may be easily improved and when all this is done the time will be ripe for more elaborate methods.

WHY RAILS BREAK IN TRACK.

Since the publication of the report of Mr. Thomas Andrews in *Engineering* (Feb. 26, April 16, 1897) upon the St. Neots rail, which broke into 17 pieces on the Great Northern Railway of England, there has been considerable dyspeptic discussion among engineers and editors as to the causes which produce such disasters, the general verdict being that the steel was very bad. A contemporary, in speaking of the microscopic cracks found in the worn top surface of the rail, says: "Such cracks, incipient and well developed, are, it is well known, frequently found in such a quality of high steel as well as sometimes in low steel before it has had any use whatever, and hence before any fatigue could have set in." The fact of the matter is, the rail under consideration had been in use for 22 years and was worn out. Experience and expert opinion in this country recommend 0.60 per cent. carbon in rails of heavy section, notwithstanding the fact that Mr. Andrews says the 0.53 per cent. carbon steel rail noted is too high and would advise 0.35 to 0.42 per cent. It is also well known that sulphur has a tendency to make steel red-hort, but it is not an acknowledged fact that it also makes it cold-short, although long service may possibly produce some such effect. New rails, on the contrary, are toughened to a very considerable extent by high sulphur, as is proven by accurate observation. The St. Neots rail contained 0.09 per cent. sulphur. Andrews recommends not above 0.06 per cent., while our best practice allows 0.07 per cent. At the time when our knowledge of steel was quite elementary, it was customary to lay the blame for failures upon the composition of the steel; we now know that there are other factors just as important, and even more so than composition under modern specifications.

Carbon is the element which characterizes steel. The lighter sections of rails usually contain 0.45 per cent. carbon, while the modern heavy section runs from 0.55 to 0.65 per cent. With an 80-pound rail we may expect the following tensile properties:

	Modern 0.60 per cent. C.	Common 0.45 per cent. C.
Tensile strength	125,0001-30,000	80,000-110,000
Elastic limit	55,000- 65,000	35,000- 45,000
Elongation (drop test)	14-18%	3-12%

We here see some points of superiority in high carbon steel which are not accounted for by composition alone. By suitable chemical composition rigid inspection, and tests following the rolling as closely as possible, the modern rail has not only gained in strength, but a remarkable increase in elongation under the drop test is shown, which is accounted for almost entirely by intelligent supervision in heating, rolling, hot-bed practice and straightening. The causes for breaking under the severe drop test of 2,000 pounds falling 20 feet are therefore principally due to an abnormal condition of the steel due to the method of manufacture, and not to composition alone.

The various constituents of rail steel and their influence upon tensile strength are quite accurately expressed by the formula of Mr. P. H. Dudley, which refers to a normal steel of about 0.55 per cent. carbon, and agrees quite closely with all steels having between 0.45 and 0.65 per cent. carbon. This formula is used as a check upon laboratory and drop tests and is not intended to apply to all steels under all conditions without certain reservations and corrections. It has been developed from actual contact with conditions of manufacture and testing, and is no doubt the most accurate yet developed. For our purpose it expresses the influence of various constituents (symbols represent per cent.) upon the tensile strength of Bessemer rail steel.

Tensile strength $= 38{,}000 + 80{,}000\ C + 25{,}000\ Mn + 20{,}000\ P + 8{,}000\ Si$.

This value must finally be corrected by certain factors derived empyrically from observation on the rails during manufacture, and it depends upon the manner of rolling, the size of rolled section, per cent. reduction from ingot to final section, upon hot-bed practice—method of cooling—and changes in mill practice with special reference to oil, gas or coal fuel, size of ingot and method of heating. Either of these may require a correction up to 10 per cent., more or less, according to degree, so that the final equation should contain also the mechanical factors as well as the chemical factors, although the investigations have not gone far enough as yet to do this for general practice, as each will require different factors. Any deviation of results from the equation will therefore represent mechanical conditions which must be looked up and corrected, as the life of rail depends directly upon these mechanical conditions.

Rails are now tested by placing a rail-butt, which would otherwise be scrap steel, upon two rigid steel supports spaced 3 feet—about two tie spaces—sometimes head up, sometimes side up, with, according to the Dudley system, equidistant punch marks on the maximum flexion fiber by which to measure the elongation. Then, in the best apparatus, a weight, falling in guides, is allowed to drop freely from a height of 20 feet upon the rail, midway between supports. A brittle rail will break—and some will withstand five such blows—but this is not the entire object of the test. What is desired with a stated composition is toughness as determined by comparative elongation, and rigidity as determined by deflection. For example: a single drop upon an 80-pound rail of 0.60 per cent. carbon caused it to deflect 2.16 inches and spring back to 1.60 inches permanent deflection, show-

ing an elastic reaction of 0.56 inches. The same weight and rail, with supports spaced 4 feet, and a drop of 13 inches, returned to its original straight condition, not having had its elastic limit exceeded, while a 20-foot drop caused a permanent set of 2.46 inches and an elastic reaction of 0.81 inch. The total elongation is taken after two drops in each instance, as one drop of 20 feet is not sufficient to reach the full limit. The final elongation agrees well with that obtained in a tensile testing machine; the use of suitable chemical composition has done much to improve this factor.

Hardness is obtained by increasing carbon or rolling while rather cool. "Hot-rolling" makes a soft steel which will warp on the hot-bed on cooling, while blue "cold-rolling" increases its surface hardness and tensile strength, but puts the rail into a bad mechanical condition which shortens its life in track by reason of severe internal stresses. A happy medium with a thin head will give the best results. The top of the rail should not be ridged or round, but should conform to the shape of the tire, as otherwise wheel pressure will cause the surface metal to flow, the hard surface skin will be worn through and the rail will not only wear rapidly, but will also deteriorate deeper into the head of the rail. Thick heads have been abandoned largely, because so much metal in the section caused the head to cool so slowly that it was practically in an annealed or softened condition when it should have been at least as hard as the rest of the rail.

Suppose a lot of rails, just received by a railroad, have been made under specifications and inspections: it is at least hoped that they are free from roll cracks in the flanges and from splinters or chisel marks of any kind. We cannot be so sure as to long hollow spaces or pipes in the rail, small flattened spaces or compressed blow holes, segregations, or incipient cracks produced by careless straightening. All these require that the inspection be more than usually thorough, and that the inspector be a specialist in the subject of steel. Let us suppose the rail to be free from these defects which would be points of weakness where breakage would probably first take place; we would first have to look for any dents in the flange of the rail. If one is found, a tie should be placed under this point and additional spikes put in, for the rail will break at such a point long before it will at any other.

Fatigue is the gradual deterioration or breaking down of the steel due to the movement of the particles of steel among themselves. Therefore in a break due to continued stresses, the time required varies directly with the number of such stresses and inversely with their magnitude. As a line of weakness exists between any two adjacent areas in different mechanical conditions, the border line between them will be where fracture first occurs whether these areas differ through temper, annealing, compression or shear. Suppose one rail falls across another in unloading and the head of one makes a dent in the flange of the other, or suppose a trackman's maul misses a spike and dents the flange; in either case a fracture will be likely to ultimately occur at this point starting in a curve around the edge of the bruise, extending diagonally, then straight across the bottom until the flanges are broken. It will then rise into the web, run nearly horizontally for a short distance, rise in a curve to the head and break square through it. A large proportion of rail breakages occur in some such manner. It is extremely rare that a rail in normal condition breaks in ordinary service unless it is worn out, when, like the "one-hoss shay" or the St. Neots rail, it goes to pieces all at once. An average life of 15 years for most light rails now in track can be assumed with safety if the traffic is not severe and the rails are carefully made. Low prices, cheap labor, high pressure mill practice, and a determination bordering on desperation of the mill superintendent to make whatever is required, without regard to the ultimate results, have resulted in the production of a large number of inferior rails, whose life in service is not as long as it should be. This has been met by specifying heavier sections of greater rigidity, so that the unit load is much less now than formerly, and longer life can be expected.

Referring to the excellent work of Mr. P. H. Dudley (*School of Mines Quarterly*, January, 1897), we find that the old 4.5-inch rail, 16 ties per rail, with 20,000 pounds per driving wheel, had a fiber stress of 12,000 to 16,000 pounds per square inch. With 5-inch rails these figures reduce to 5,000 to 8,000 pounds, while in the 6-inch 100-pound rail the highest stress yet noted is 4,000 pounds. This under a wheelbase of 8 feet 6 inches and static loads. We see that in going from a 60-pound rail to a 100-pound rail we have reduced the working stress to one-fourth, and have a rail less subject to the effects of fatigue, and of such stiffness that the wear on rail, joints, spikes, ties and ballast is reduced to a minimum.

When rails break through the end bolt hole the fracture through the hole is at an angle of about 45 degrees either way. Various persons attribute this to as many causes. Advocates of patented joints claim that the under side of the rail head wears both itself and the angle bar at the end; then when the wheel jumps over the joint, the rail remains rigid and the rail end bends down slightly and ultimately breaks. They therefore recommend a "base support" or reinforced plate under the joint. It sometimes happens that the bolt hole in the rail is improperly spaced and that in cold weather there is considerable tension on the rail. Every joint deflection increases this tension and finally the combination of tension and bending moment breaks off the end. Some also contend that the side blow due to lateral oscillation of cars on track or pressure on curves will tend to twist the rail and assist in its fracture. Joints which are too wide open certainly contribute largely, for a hammer blow on the rail end, far exceeding in effect an equal static load, occurs at every wheel, proportional in severity to the space jumped over. Trackmen differ as to placing the joint over a tie or between two ties. Angle-bars break from above downward, while rails break from below upward. Therefore the microscopic cracks noted by Mr. Andrews, before referred to, probably had no bearing on the subject.

Other causes for breaking of rails may be the hammer blow of the excess of counterbalance possessed by locomotive drivers, the thump of "flatted" wheels, cold weather, poorly tamped ties, an old tie between two new ones, or a tie cut into deeply by the rail where no tie-plate is used, wrecks, and other contributory causes, all of which have their influence. In general, a blow gives the more severe stress, and if such blows succeed each other at a point where some part or all of the section has had its elasticity destroyed by a bruise, a cut, a dent, a gag mark, cold bend, or similar cause, fatigue will occur and fracture follow in one or several stages.

In order that a rail shall not break in service the following conditions must be satisfied:

1. It must be of such a strength that the working stress shall not exceed one-fifth the elastic limit. 2. It must have sufficient toughness not to break with such deflections as may occur in poor track, and sufficient rigidity to distribute all shock or vibration over several ties instead of one, and thus insure smooth riding, even if the ties are poorly tamped. 3. There should be no internal stresses locally distributed in the steel due to cold rolling, unequal cooling, cold bending (as far as possible), or local heating. 4. There should be no dents, flaws or other signs of bad usage on the rail; in some roads a splice bar is placed at such a mark in anticipation of the rail breaking there. Rails must be carefully handled, especially when of small elongation and high carbon. 5. Eternal vigilance in track inspection, supplemented occasionally by some such record as is given by a dynagraph car, or similar device, is necessary; and above all, the realization that brains in manufacture, inspection and maintenance are worth as much as brains in anything else.

TEN WHEEL VS. MOGUL LOCOMOTIVES.

For a good many years a favorite topic for discussion at technical meetings of railroad men has been the relative merits of mogul and 10-wheel engines. It has been generally claimed that the mogul engine permits of an ideal distribution of weights, all of the weight of the engine being available for tractive purposes except the 15,000 to 20,000 lbs. carried on the two-wheel truck, while in the 10-wheel en ine a larger percentage of the

total weight must be carried upon the truck. In favor of the 10-wheel engine it has been urged that the four-wheel leading truck is a safer and simpler construction and gives less trouble from the cutting of truck-wheel and driving-wheel flanges. Whatever may have been the force of these arguments in the past, it appears now as if the choice between the two types is to be decided upon an entirely different basis and in favor of the 10-wheel engine. The tendency of modern locomotive design is toward very large boilers and rightly so, and assuming that the conditions of the service necessitate three pairs of drivers, it generally happens that when a boiler large enough for modern requirements is provided the total weight of the engine becomes greater than is desirable to carry upon three pairs of drivers and one pair of truck wheels. This is the case even when liberal weights per axle are permitted. Furthermore, modern practice in several details has a tendency to move forward the center of gravity of the engine and place more weight on the leading truck. Thus the great strength needed in cylinders and cylinder saddles on account of the high steam pressures carried necessitates the use of heavy walls and flanges throughout these castings. The fastenings between the two half saddles and between the saddle and the boiler are now of greatly increased strength and have involved a large increase of weight at this point. The better fastenings of the cylinders to the frames also add considerable weight, and the frames themselves are made much heavier in front of the front jaw than in the past. Add to this the heavier smokebox rings and liners in the smokebox, and we have altogether a large accession to the weight which must be carried on the truck. Furthermore, the use of radial stays instead of crown-bars reduces the weight at the back end of the boiler, thereby causing a transfer of weight from the drivers to the truck. The result of these changes in details is to make the weight on the forward equalizing system of a mogul engine greater than can be conveniently carried there, for if the weight on the two-wheel truck is kept within reasonable limits the weight on the front pair of drivers becomes greater than that upon either the main or rear pair of wheels. True, this difficulty can in part be overcome by a long "overhang" of the boiler back of the rear drivers, but the limit in this direction is soon reached, particularly if it is not considered desirable to have the boiler extend into the cab further than in the common eight-wheeled engine. Thus it appears quite clear that in designing an engine for heavy service in which three pairs of drivers will be needed to carry the tractive weight desired, the 10-wheel engine is much to be preferred to the mogul engine, because of the greater total weight of engine that can be obtained within a given limit of axle loads, and because the four-wheel truck is needed to carry the greater weight now placed on the leading truck by recent changes in details of locomotive construction and because of the greater elasticity or general adaptability of the design.

NOTES.

The letter ballot upon the standards and recommended practice of the Master Car Builders' Association, which closed Aug. 2, resulted in the adoption of all the questions submitted. Two standards and six recommended practices are thereby added to the association's list.

Sanding the ends of postal and other cars which are run next locomotive is shown by Mr. A. J. Bishop, writing in the *Railroad Car Journal*, to be a very satisfactory practice. He describes a portable sand blast apparatus for applying the sand and shows that the work may be done for 24 cents per coat per car end for paint and sand.

Under the caption American Rails for India the *Mechanical World* discusses the recent underbidding of English railmakers for the business of the Indian railroads by £1 per ton on a total of £8,000 on a single order and preaches the doctrine of protection to home industries. This is a high tribute to American railmakers and their method of securing low cost of production.

A year or so ago the Lehigh Valley road proposed to its shop employees to make for them and their families the low passenger rate of half a cent a mile in lieu of passes, and to devote the entire receipts to a fund for the employees' benefit. According to the *Railway Age* about $15,000 has already been realized by this co-operative plan and 15 superanuated workmen now receive regular incomes therefrom.

The Atchison, Topeka & Santa Fe is putting up block signals on 73 miles of its main line in Kansas and on 100 miles of the Emporia branch. Apparatus and electrical connections will be used similar to those on the Chicago, Milwaukee & St. Paul Railway. Several new telegraph offices will be established. The Atchison has 14 miles of automatic electric block signals between Kansas City and Holliday.

The latest development in the direction of transportation equipment is the Behr Monorail Electric Railway, of which a sample is now in operation in connection with the Brussels Exhibition. It embodies a car of peculiar shape, a great deal of machinery, a single rail structure of V section and more strange ideas than are ordinarily found even in 150 mile per hour, electric, air line railroad schemes.

Conditions of railroad operation must be changing much more rapidly in this country than in England. We are told by an English engineer that on the Great Northern Railway a type of locomotive designed 28 years ago has been perpetuated and repeated with success ever since with scarcely any change even of details. We wonder how an American eight-wheeler of 28 years ago would feel in tackling the Empire State Express of to-day.

The beauty of the electrical illumination of the British warships at the recent review at Spithead must have been striking. *The Engineer* informs us that the total illuminating power of the fleet was about 739,320 candles, and that 3,850 horse-power was required to drive the dynamos. An idea of the number of lamps is given by the statement that when put in a single line and 5 feet 6 inches apart they would reach about 54 miles. This will undoubtedly be charged to development of patriotic pride in the navy—a worthy object.

The latest Niagara power scheme is the utilization of the power of the falls through impulse wheels, and Mr. F. M. F. Cazin proposes to get a head of nearly 200 feet by means of a flume and penstock constructed through the solid rock. The pressure wheel will undoubtedly do the work more efficiently than the slow-speed turbine in present use at the falls, and the former would give the additional advantage of higher generator speeds. These wheels would permit of saving much of the present waste of head at the plant of the Cataract Construction Company.

The steps just taken by the Navy Department to secure an additional supply of rapid-fire guns puts beyond question its ability to arm seasonably the vessels of the merchant marine now counted upon as auxiliary cruisers. There are 19 such vessels on the Atlantic coast and nine on the Pacific, the former including the large passenger steamers *New York*, *Paris*, *St. Louis* and *St. Paul*. The current contract arrangements include six 6-inch guns, twenty-five 5-inch and fifteen 4-inch.

Railway speeds in England for this year have not increased, but to the great sadness of Mr. Chas. Rous Martin, writing in *The Engineer*, have decreased with respect to the traffic to the North, and the glory of running the fastest regular trains remains to the United States. The record for long continuous runs is held by the Great Western Railway, with a regular train from London to Exeter, 194 miles, without a stop. The London & North Western continues to run four regular trains daily from Euston to Crewe, 158 miles, without stopping.

One of the interesting features of the Shoreditch (England) electric installation is the use of accumulators. The battery is capable of discharging at a rate of 171 amperes for six hours at least, and of maintaining a minimum electromotive force of 165 volts throughout the discharge. It is also capable of being discharged at a much higher rate, the maximum being 350 amperes.

The capacity of the battery for a higher discharge rate than the normal being 272 amperes for three hours, the minimum electromotive force of 165 volts being maintained in all cases.

The electric capstans used for switching cars on the Northern Railroad of France are described in the *Revue Generale des Chemins de Fer*. A capstan is placed in an angle between the tracks, where a rope can be easily led either to the turntables or the cars on the adjacent tracks. The motor is horizontal, the armature shaft being geared directly to the spindle of the capstan. The capstan machinery is very carefully protected from water, and no trouble has been experienced in this direction. The rheostats and other controlling devices are placed in the cavity containing the motor.

The M. C. B. axle to carry 31,000 pounds is discussed editorially in a recent issue of the *Railway Master Mechanic*, and while the design is approved as far as the engineering of it is concerned, it is suggested that the journal might have been made 8 inches long instead of 9 inches. The shorter journal would offer the advantage of permitting the axle to be used in other journal boxes and with lighter loads when it had worn down too small for a load of 31,000 pounds. The conclusion reached is that the 9-inch journal will not be used by roads handling cars of various different capacities.

The new Sprague system of electric traction, which is to be applied to the cars of the South Side Elevated of Chicago, was tried on the experimental track of the General Electric Company at Schenectady July 26. The train of six cars was controlled by the multiple unit system from the forward car. Each car has two 50 horse-power motors and the whole train may be handled from the platform of any car, either during switching or after the train is made up. The current is supplied to each car separately and perfect independence of the cars is thus secured. The trial was a success both as to speed and control.

Ground was broken in New York City, Aug. 2, for the pneumatic mail tube system, which is expected to be in operation on Oct. 1. The first tubes will consist of two double lines of 8-inch tubes, one between the Produce Exchange and the Post-Office, by way of South William, William and Beekman streets, the other extending from the Post-Office to the substation at Forty-fourth street and Lexington avenue, and connecting with substations along the route. Another system of tubes, to be constructed later, will extend from the General Post-Office to the Brooklyn Post-Office by way of the bridge and under Washington street, Brooklyn.

The many friends of Lehigh University will be glad to know that the financial relief which is provided by the State will enable the institution to pursue the work in which it has so long been engaged. The temporary embarrassment was occasioned by the failure of holdings of railroad stock to pay their usual interest, and the sum of $150,000 which the State has furnished is timely. The plans for future development of the University are not to be curtailed, and it is likely to become stronger than ever among the institutions of its class. There was no foundation for reports that its doors were likely to be closed, but undoubtedly the work would have been seriously curtailed had the State not made this liberal grant.

Three notable cases of broken propeller shafts on ocean steamships have occurred within a short time. The shaft of the North German Lloyd ship *Spree* broke on the voyage leaving New York June 28, and the shaft of the *Cephalonia* is reported to have been so badly sprung on the morning of July 4 as to disable the ship. The third case occurred upon the Hamburg-American liner *Normannia*, and was discovered on the morning of July 29, just as the ship was to leave the dock at Hoboken, N. J. In this case the break extended about two-thirds through the shaft, and it was fortunately discovered before the ship had put to sea. These three cases occurring so close together draw attention to the subject of the effect of repeated stresses and the vibrations of the shafts, or of the ships on a whole, as one which is worthy of study.

The comparative cost of maintenance of M. C. B. and link and pin couplers is stated by Mr. R. M. Galbraith, General Master Mechanic of the St. Louis Southwestern Railway, writing in the *Railroad Car Journal*, to be $389.37 for 63.2 per cent. of the cars which were equipped with the link and pin, as against $73.23 for the maintenance of M. C. B. couplers upon 36.8 per cent. of the cars. He also shows that 85 per cent. of the break-in-twos of trains were caused by links of link and pin couplers breaking, or by the breakage on jumping of the pins. These figures are taken to show that the M. C. B. coupler is here to stay, as this writer puts it. The information is interesting in view of the fact that many blame the new coupler for troubles that are considered worse than those which were experienced before it was introduced.

An ingenious device for automatically regulating the feed pumps of boilers of the water-tube type has been worked out and applied by Messrs. Yarrow & Company. It consists of placing the steam pipe that supplies the pump with its opening in the boiler at such a level that it will be covered by water when the water in the boiler has reached the proper height. The pump is worked by steam when the water is below that level and by water when above it. The pump runs very slowly when driven by water, and when the engines are shut down the pump throttle is presumably closed. The pump makes about 45 strokes per minute when driven by steam and about six strokes per minute when driven by water. An attachment whereby the end of the admission pipe may be easily raised or lowered completes the arrangement, which is said to operate with perfect satisfaction.

The humiliation caused by the necessity of sending the battleship *Indiana* to Halifax to be docked for cleaning and painting has brought about the appointment of a board of inquiry to report to Congress upon the needs of the navy in this respect on the Atlantic coast. The cost of docking at Halifax is an item of importance from the fact that the charge in this case is said to be $800 per day for the four days. The Halifax dry dock is the property of a company. It cost $1,000,000 to build, and it is on a good financial basis on account of the subsidies it receives from the British government, the Dominion government and the city of Halifax, each of which contributes to it $10,000 annually. It is on account of the Imperial and Dominion subsidies that the British Admiralty have a prior right to its use whenever they require it. The dock is 600 feet in length and the *Indiana* 348 feet long.

We recently chronicled the high speed of the compound steam turbine vessel, the *Turbinia*, at 32¾ knots per hour, and during the month of July the same boat, which it will be remembered is only 100 feet long, made a record of 35 knots, or 40 miles per hour. At this speed, Mr. Parsons says, the engines indicated 2,400 horse-power, with an expenditure of 14 pounds of steam per indicated horse-power per hour. These results warrant looking to the steam turbine for important improvements in marine propulsion in spite of certain disadvantages possessed by these engines. The chief difficulty at present is that they will not reverse, but this is not believed to be insuperable. Trials with larger vessels at lower rotative speeds of from 250 to 500 revolutions per minute may be looked for in the near future, and Mr. Parsons says that for large ships the turbines would be even more simple than those in the *Turbinia*.

The Liverpool Overhead Railway uses gearless motors and of these Mr. S. B. Cottrell, Engineer and General Manager, says: "I consider that the gearless motor is better for our work than a single reduction motor. The cost of repairs to motors is trifling compared to what the cost of repairs of locomotives would be to work a similar service. To effect repairs the wheels and axles are taken out of the truck frames and there is no difficulty in repairing the armatures on the axles. I do not see that there is any more trouble with the failure of armatures with gearless motors than there would be with geared motors. I do not think that either gearless or geared motors make any difference to the track joints, as the blow in either case must be the same." As to the location of the third rail he says: "The conducting rail should be, wherever practical, put in the center, as we have done here,

for we find no difficulty with it even at complicated crossings, whereas placing at the side and higher than the running rail, would offer many complications at cross-over roads."

Mr. M. H. Gerry, Jr., in a paper recently read before the American Institute of Electrical Engineers, gave some interesting data concerning the wastes occurring in the use of electricity upon the Metropolitan Elevated in Chicago. The loss by heating the motors on one of the cars which are capable of exerting a drawbar pull of 4,000 pounds, working under ordinary conditions, with an atmospheric temperature of 60 degrees Fahr. is about 15 horse-power. Starting at the engine shaft the losses are as follows: The generator will return about 90 per cent. of the work put into the armature shaft; of the amount furnished by the generator, from 10 to 25 per cent., and may be more, is lost in transmitting the current from the generator to the controller on the car; the losses in motor and car apparatus are such that 50 per cent. of the power supplied by the generators is lost between the generators and the car axle. This may be stated as follows: If 51 horse-power is required to propel the train there must be 108 horse-power provided at the engine shaft.

In speaking of the selection of tools for workshops an English contemporary, *The Practical Engineer*, clearly expresses the importance of capacity and simplicity of tools which are to be given hard usage. The author admits that it seems a pity to sacrifice old tools which are capable of doing much work. There is some sacrifice in doing away with them, but the change is not all sacrifice. Compare the lathe which used to do duty as a general tool, which may be employed to turn a bolt or stud, or bore a hole just as required, with the capstan head machine, with its six or eight special tools, the hollow mandrel and its gripping jaw, with which a boy can turn out special bolts or studs, without any alterations that involve much trouble, no time being wasted in centering or looking for carriers, etc., and one can easily estimate the value of the gain that such a tool is in a workshop. A technical education we need is the power to discriminate between the cheap and well-designed tools offered by the best makers and the lower-priced but very costly devices offered, like patent medicines, as being capable of doing anything required and result in being a source of annoyance to all concerned.

Compressed air is one of the most flexible of power transmitters and to this attribute it owes much of its success. Mr. A. Kirk, in a recent discussion before the Engineers' Society of Western Pennsylvania, in speaking of the transmission of air-pressure through a considerable distance said: "We were working in a stone quarry on a large drill, I think it was 3½ diameter. The quarry was started within 100 feet of the compressor. We worked there for some time, but a change in the strata of rock showed the rock contained too much silica for furnace purposes, and we had to go nearly a mile and a half away from the compressor and begin operations again. We were contemplating, and even made arrangements, to move the compressor nearer to the new quarry, but the compressor was in a very convenient locality, near other machinery, and if it could remain where it was it would save the expense of an independent engineer, and save the trouble of carrying coal and water. I finally insisted that it should remain where it was, stating that we could pipe the power to where we wanted it. This was done, and we found that we could use the compressed air through a 1½-inch pipe to as much advantage a mile and a half away from the compressor as we could within 100 feet of it.

Personals.

Mr. George W. Turner, formerly Superintendent of Motive Power of the St. Paul & Pacific, died at St. Paul July 7, aged 66 years.

Mr. F. P. Boatman has been appointed Master Mechanic of the Columbus, Sandusky & Hocking, with headquarters at Columbus, O.

Mr. Nat C. Dean has been appointed Western Representative of the Fox Pressed Steel Company, with office 1413 Fisher Building, Chicago.

Mr. David Anderson has been appointed Master Mechanic of the Northern Ohio, with headquarters at Delphos, O., to succeed Mr. J. T. Clark.

Mr. A. L. Whipple, Manager of the railroad department of the Boston Woven Hose and Rubber Company, has removed his headquarters to 205 Lake street, Chicago.

Mr. S. King has been appointed Master Car Builder of the middle and northern divisions of the Grand Trunk, and will be in charge of the car shops at London, Ont.

Mr. F. H. Coolidge has been appointed Western representative of the Lappin Brakeshoe Company and the Gold Car Heating Company, jointly, at Chicago.

Mr. Daniel S. Lamont, who was Secretary of War under President Cleveland's administration, has been elected Vice-President and Director of the Northern Pacific Railway.

Mr. Jesse Fry has been appointed General Manager of the San Antonio & Gulf Shore, with headquarters at San Antonio, Tex., in place of Mr. George Dullnig, resigned.

Mr. David T. Bound has been appointed General Superintendent and Purchasing Agent of the Wilkes-Barre & Northern at Wilkes-Barre, Pa., to succeed Mr. A. A. Holbrook, resigned.

Mr. C. A. De Haven has been appointed Master Mechanic of the Kansas Midland Railway, and will have charge of all matters pertaining to the locomotive and car departments, with headquartersat Wichita, Kan.

Mr. R. D. Wade, who was for many years Superintendent of Motive Power of the Richmond & Danville, afterward absorbed by the Southern Railway, has accepted a position with the Baldwin Locomotive Works.

Mr. R. H. Soule, who recently resigned the position of Superintendent of Motive Power on the Norfolk & Western Railway, has accepted an appointment with the Baldwin Locomotive Works, beginning Aug. 1.

Mr. George S. McKee, Master Mechanic of the St. Louis division of the Cleveland, Cincinnati, Chicago & St. Louis, at Mattoon, Ill., has been appointed Master Mechanic of the Wabash, with headquarters at Moberly, Mo., to succeed Mr. Thomas E. Butterly, resigned.

On account of ill health, Mr. E. M. Humstone, Assistant Superintendent and Master Mechanic of the Philadelphia, Reading & New England, has been granted a leave of absence, commencing Aug. 1. Until further notice Mr. H. Schaefer will act as Master Mechanic.

Mr. Emil Gerber has been appointed Chief Engineer of the Lassig Bridge and Iron Works, Chicago. Mr. Gerber and the bridge company are to be congratulated on the appontment. We have received the notice too late to say more about Mr. Gerber's work than that he has for a number of years been associated with Mr. George S. Morison.

Mr. L. E. Johnson, Superintendent of the Michigan Division of the Lake Shore & Michigan Southern, has been appointed General Superintendent of the Norfolk & Western, with headquarters at Roanoke, Va. He was born in Aurora, Ill., in 1846, and began railroad work in the shops of the Chicago, Burlington & Quincy. He passed successively through the positions of fireman, engineer master mechanic and division superintendent on that road. In 1888 he left the Chicago, Burlington & Quincy to accept a position as Superintendent of the Montana Central. He remained there till 1893, when he accepted a division of the Lake Shore & Michigan Southern.

Mr. S. R. Callaway, President of the New York. Chicago & St. Louis, was on Aug. 18 chosen President of the Lake Shore & Michigan Southern, with headquarters at Cleveland, O., to succeed the late D. W. Caldwell. Mr. Callaway succeeded Mr. Caldwell as President of the N. Y. C. & St. L. in January, 1895, and previous to that date was for over four years President of the Toledo, St. Louis & Kansas City. He was Second Vice-President and

General Manager of the Union Pacific system from September, 1884, to June 30, 1887, and from 1881 to 1884 was General Manager of the Chicago & Grand Trunk, and President of Chicago & Western Indiana and Belt Railway of Chicago.

Mr. Edmund S. Bowen, who has had a long and successful railroad career, died Aug. 19, in New York City, He was born in 1831 at Martinsburg, Pa., and entered railroad service at the age of twenty; since that time he has held the following positions: Rodman engineer corps of the Pennsylvania Railroad, Assistant Engineer of the same road, Assistant Engineer of the Sunbury & Erie, Resident Engineer of Northern Central, Division Superintendent of the same road, General Superintendent and Chief Engineer of the Kansas Pacific, General Superintendent of the New York, Lake Erie & Western, and Vice-President of the same road, from which position he retired in October, 1885, on account of ill health. In September, 1888, he was made General Manager of the Rome, Watertown & Ogdensburg, and 1892 he was made Assistant to the President of the New York & New England road.

Mr. Henry S. Marcy, President of the Fitchburg railroad, died suddenly from a stroke of apoplexy, at his home in Belmont, Mass., Aug. 10, at the age of 60 years. He was born at Hartland, Vt., Jan. 28, 1837, and entered railway service April 1, 1858, as Master of Transportation of the Sullivan railroad. After holding that position for 3½ years he went to the Rutland & Bennington, Oct. 1, 1861, as clerk to the superintendent, and in May, 1863, was made Master of Transportation. He was Acting Superintendent of the same road from July, 1864, to November, 1865, and was then until May, 1871, General Freight Agent of the Rensselaer & Saratoga. He was appointed General Freight Agent of the Delaware & Hudson Canal Company in May, 1871, and held that position for 14 years. He was then Traffic Manager of the same company until Nov. 1, 1889, when he was chosen President of the Fitchburg Railroad.

Mr. C. S. Mellen, Second Vice-President of the New York, New Haven & Hartford, was chosen President of the Northern Pacific at a meeting of the board in New York Aug. 12, to succeed Mr. E. W. Winter, whose resignation was accepted, to take effect Aug. 31. The new president is 46 years of age and has been in railway service since 1869. His first railroad work was with the Northern New Hampshire, where he began as a clerk in the cashier's office. He remained with that road in various minor positions until 1880, with the exception of one year's service with the Central Vermont, and on Oct. 1, 1880, was appointed Assistant to the Manager of the Boston & Lowell. He was successively Auditor, Superintendent and General Superintendent of that road until June 1, 1888, when he accepted the position of General Purchasing Agent of the Union Pacific. The following November he was made Assistant General Manager of the Union Pacific, and on March 1, 1889, was appointed General Traffic Manager of that system. He resigned the latter position April 1, 1892, to accept the position of General Manager of the New York & New England, and was chosen Second Vice-President of the New York, New Haven & Hartford, Oct. 27, 1892.

Books Received.

LA MACHINE COMPOUND. Conférence par A. Mallet, Ingénieur Civil. Extract du Bulletin de la Société Industrielle de L'Est. Nancy, 1897.

RECONSTRUCTED AMERICAN MONITORS. By Passed Assistant Engineer F. M. Bennett, U. S. Navy. Reprinted from Journal of the American Society of Naval Engineers.

ELEVENTH ANNUAL REPORT OF THE COMMISSIONER OF LABOR, 1895-1896. Work and Wages of Men, Women and Children. Government Printing Office, Washington, D. C., 1897.

TWENTY-EIGHTH ANNUAL REPORT OF THE BOARD OF RAILROAD COMMISSIONERS OF THE STATE OF MASSACHUSETTS, January, 1897. Public Document, No. 14.

MODERN FREIGHT CAR ESTIMATING, Containing Necessary Information and Tables Appertaining to the Proper Method of Compiling Correct Estimates on Freight Equipment. For Car Manufacturers and Railroad Officials. Edited by O. M. Stimson. Anniston, Alabama, 1897, 500 pages, illustrated, folding tables, standard size (6 by 9 inches), flexible morocco, gilt. Price, $5.00.

TRANSACTIONS OF THE AMERICAN INSTITUTE OF MINING ENGINEERS, Vol. XXVI., February, 1896, to October, 1896, inclusive. New York. Published by the Institute, 1897.

MICHIGAN ENGINEERS' ANNUAL, Published by the Michigan Engineering Society, 1897.

STATE SUPERVISION OF GRADE CROSSINGS OF STEAM AND ELECTRIC RAILROADS. By Charles Hansel, M. Am. Soc. C. E.

PROCEEDINGS OF THE FOURTH ANNUAL CONVENTION OF THE ASSOCIATION OF RAILROAD AIR BRAKE MEN HELD AT NASHVILLE, TENNESSEE, April 1897.

ARMOUR INSTITUTE OF TECHNOLOGY ANNUAL YEAR BOOK FOR 1896-1897, with announcements for 1897-1898.

THE OFFICIAL RAILWAY LIST, 1897. A Directory of Presidents, Vice Presidents, General Managers, etc., and a Hand-Book of Useful Information for Railway Men. Sixteenth year. Chicago: The Railway List Company, 1897. Price, cloth, $2; flexible leather, $3.

THE ENGINEER'S SKETCH BOOK OF MECHANICAL MOVEMENTS, DEVICES, APPLIANCES, CONTRIVANCES AND DETAILS. By Thomas Barber, Engineer. Third Edition, 2603 illustrations. London, E. & F. N. Spon. New York, Spon & Chamberlain, 1897. Price, $4.

THE STONE INDUSTRY IN 1896. By William C. Day. Department of the Interior, U. S. Geological Survey. Charles D. Walcott, Director. Washington, Government Printing Office, 1897.

HERZOGLICHE TECHNISCHE HOCHSCHULE CUROLO WILHELMINA ZU BRAUNSCHWEIG. Programme for the years 1897-1898. Braunschweig, 1897.

LIGHT RAILWAYS. Practical Hints for Light Railways at Home and Abroad. By F. R. Johnson, Late Executive Engineer Assam-Bengal Railway, Mem. Am. Soc. C. E. London, E. & F. N. Spon New York, Spon & Chamberlain, 12 Cortlandt street. Price, $1.

MAXIMUM STRESSES IN FRAMED BRIDGES. By William Cain Member A. S. C. E., Professor of Mathematics in the University of North Carolina. New York, The Van Nostrand Science Series, No. 38. New York, D. Van Nostrand Company, 1897. Price, 50 cents.

New Publications.

MODERN FREIGHT CAR ESTIMATING. Containing necessary inmation and tables appertaining to the proper method of compiling correct estimates on freight equipment. Edited by O. M. Stimson. Anniston, Ala.: Stimson & Company, 1897. Octavo, 510 pages, with index, engravings and folding tables; flexible morocco, gilt. Price, $5.

This book was written for the use of railroad car department officers, freight car builders, estimators and others who have to do with the details of car construction or repairing, and is the result of the thought given to this subject during 16 years of experience which the author had in various departments concerned with car works, five years of which were spent with the Pullman Company. It is a very elaborate work, bearing upon the proper method of making correct and intelligent estimates upon railway freight equipment. But the object of the author was to accumulate and reduce to concise form the very large amount of information necessary to compile a complete estimate, and further to afford accurate references to comparisons of the difference in cost between the various appliances entering into freight car construction. The introductory chapter, under the head of compiling of estimates, treats at considerable length of the duties of the various department heads in car manufacturing and railroad shops. This is followed by chapters dealing with the various appliances such as trucks, bodies, draw gears, bolsters, brakes, roofs and doors. Under each of these divisions is subdivided the large number of different devices each beginning with the Master Car Builders' standard or recommended practice, and upon which as far as possible all are based. These are accompanied by drawings. Complete bills of materials in the minutest detail are given, followed by summaries, thus enabling the purchaser with very little work to price the quantities in his own territory, thereby enabling him to have accurate and detailed comparisons of the difference in cost between the application of one device and another. An appendix gives carefully selected weights and measures commonly used in car estimating, and the complete specifications of all material entering into freight car construction as required by the Pennsylvania Railroad are reproduced in a second part. Another appendix contains blank forms for complete bills of material. The book is well printed and well bound.

Some of the illustrations are reduced to too small a scale, but aside from that we commend it strongly in every respect, and believe that all car department officers and car builders who have to do with estimating will be glad to have it. The preparation of the work was thorough and much information is given in connection with the chapters on trucks, car doors, draft gears and bolsters.

THE MATERIALS OF CONSTRUCTION: A TREATISE FOR ENGINEERS ON THE STRENGTH OF ENGINEERING MATERIALS. By J. B. Johnson, C. E., Professor of Civil Engineering in Washington University, St. Louis, Mo. First edition. New York: John Wiley & Sons. London: Chapman & Hall, Limited. 1897. Price, $6.

This book is one of the most valuable of recent additions to engineering literature, and it would be difficult to give too much praise to the author and the publishers for rendering the contents available at this time. There has been a great deal of good material in the line of reports of tests scattered through technical literature, but it has never before been collected, digested and presented in available form for easy access and consultation. The work which has been done in this and foreign countries has been grouped and analyzed by Professor Johnson, particular attention having been given to research which has taken the direction of the establishment of fixed laws. Engineers will appreciate the book which places at their disposal the cream of the valuable records of the United States Arsenal tests conducted at Watertown, Mass., which now fill fourteen large volumes. The work done by Bauchinger, Tetmajer and Martens has also been called upon to furnish an important part in the book. The investigation of cements, mortars and concretes made during the construction of the St. Mary's River canal locks, Kirkaldy's reports and the original investigations of the author for the U. S. Forestry Division have all contributed to the book, and wherever possible the results have been shown graphically, which is one of the features of the work. The usual method of recording tests is to put them in the form of tables, and the diagrams are certainly much more convenient for consultation by busy men. This plan exhibits at a glance the relationships of the data. The subject of timber tests is very fully treated. Prior to the tests by the Forestry Division of the U. S. Department of Agriculture comparatively little was known about timber, and the author's intimacy with these tests enables him to bring out the conclusions with effect. No attempt is made to establish rules for guidance in designing or to propose original specifications to be used in the purchase of materials, but the book is the result of an effort to impart knowledge of the properties of materials, showing upon which these depend, the causes of variation and defects and instruction in means for discovering these, all with a view of preparing a reader to draw his own specifications and establish his own rules. The author rather boldly proposes the following definition: "The apparent elastic limit is the point on the stress diagram of any material, in any kind of test, at which the rate of deformation is 50 per cent. greater than it is at the origin." This, the author says, should not be made to apply to materials not perfectly elastic within any limits. He proposes to extend the meaning of the term so as to make it applicable to all elastic materials, and at the same time to make it serve as the "elastic limit" to be universally used in all kinds of practical tests. Space is not available for more than a statement of this definition and the author bespeaks careful consideration of his stress diagrams before his views are condemned. The fact is that the term "elastic limit" is a most indefinite one, and unless it is defined whenever used it means nothing. This is a most important subject and Professor Johnson's wide experience should count in estimating the value of his arbitrary method of fixing the apparent elastic limit. The sources of information given in the text and legends accompanying the engravings are acknowledged. Among the illustrations are many taken from photographs of specimens after fracture or special treatment. The book is divided into four parts. Part I. is devoted to the crushing strength of brittle materials. Part II. presents the methods of manufacture of cast iron, wrought iron, steel, alloys, cement and brick. In this part 100 pages are given to timber and timber trees, the matter never having been brought together before in such a work. Part III. describes testing machines and methods of testing, and part IV. covers the mechanical properties of materials of construction as determined by actual tests.

PROCEEDINGS AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION. Thirtieth annual convention, held at Old Point Comfort, Virginia, June, 1897.

The promptness of the appearance of this report, which must have involved a great deal of hard work on the part of the secretary, will be heartily praised by the many who heretofore have been obliged to wait much longer for an opportunity to examine the official records of the convention. The indexing of the volume has been done with care and will probably satisfy all but the most exacting critics. The binding is uniform with that recently adopted by the Master Car Builders' Association and is a vast improvement over the old method. The press-work is by the Henry O. Shepard Company and is excellent.

THE RAILWAY SIGNALING CLUB.—Constitution, List of Officers and Members, and General Rules Endorsed by the Club to Govern the Operation and Maintenance of Interlocking Plants.

This little pamphlet is sent out to show the present standing of this comparatively new organization of signal engineers. Besides the constitution, by-laws and list of members, it contains what is believed to be the best codes of rules for the operation and maintenance of interlocking plants that have appeared. The members are practically familiar with signals and their appurtenances and are better qualified than any other group of men to formulate sensible rules for these purposes. It is not to be claimed that the rules are perfect, but they are the result of deliberation and discussion among the men best fitted to know the subject thoroughly. The little book ought to attract attention to the club, and it is to be hoped that encouragement will be given its members to continue the work which has been so well begun. It should be said of these rules that they will be found exceedingly useful to railroad officers who are compiling rules for their own roads, and they may safely be used as a basis for rules specially gotten up to meet the requirements of individual roads. The officers of the Railway Signaling Club are: W. J. Gillingham, Jr., Illinois Central Railroad, President; H. D. Miles, Michigan Central Railroad, Vice-President; E. M. Seitz, Chicago & Northwestern Railway, Secretary and Treasurer. The Committee on Rules is composed of Messrs. H. D. Miles, H. M. Sperry and W. C. Nixon.

CAR INTERCHANGE MANUAL. Abstract of Decisions of the Arbitration Committee of the Master Car Builders' Association, from January, 1888, to May, 1897. Compiled by J. D. McAlpine, Cleveland, O., 80 pp. *The Railroad Car Journal*, New York, 1897. Price, 20 cents.

This little book was prepared for the use of car inspectors and others who have to do with the application or interpretation of the M. C. B. interchange rules. It is a valuable guide for them and contains abstracts of decisions of the arbitration committee, including only such cases as are of practical interest at the present time. The book also contains an index, a list of synonyms, settlement prices for cars destroyed and its closing chapter is entitled "What to do in Accidents and Emergencies." It is a valuable book for all who are concerned with the rules of interchange of freight cars.

The August number of *Cassier's Magazine* is a special marine number. It comprises 300 pages of special articles from well-known authorities on marine subjects and is handsomely illustrated. It gives pleasure to call the attention of our readers to it as an admirable presentation of the leading questions pertaining to modern marine matters. The mention of the names of Sir William Henry White, A. F. Yarrow, D. B. Morison, John I. Thornycroft, Archibald Denny, Walter M. McFarland, Leander N. Lovell, L. Meriam Wheeler, Joseph R. Oldham and John P. Holland as contributors is enough to say that this number should be obtained by everyone interested in marine engineering. The subjects are treated in such a thorough manner as to make it a valuable acquisition to any engineer's library.

KENT'S MECHANICAL ENGINEERS' POCKET BOOK.

Messrs. John Wiley & Sons announce that the third edition of this book has been issued and that all of the errors discovered up to the date of April 1, 1897, have been corrected. Errata slips may be obtained from the publishers by owners of the first and second editions. These are arranged so that they may be fastened into the books.

Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.
It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

THE BUNDY GRAVITY AUTOMATIC PUMP.—The A. A. Griffing Iron Company, 66 Centre street, New York, has prepared a little pamphlet bearing the above title, a copy of which has just been received. It illustrates and describes the gravity pump and presents engravings and an explanation of its operation.

THE MERITS OF LEAD PAINTS AND DIXON'S SILICA-GRAPHITE PAINT COMPARED is the title of an interesting 18-page standard size pamphlet, the purpose of which is put by the publishers as follows: "Much has been said and written lately concerning protective coverings for iron structural work. The growing tendency among those who have given the matter careful consideration is to add some form of carbon to the red lead used, or to discard red lead altogether. This has caused the red lead manufacturers to issue pamphlets condemning the use of carbon—especially graphite. The statements of the red lead people have been so wide of the facts that we have made reply by issuing this pamphlet." The pamphlet is issued by the Joseph Dixon Company, Jersey City, N. J.

PRICE LIST No. 12, by the Phosphor-Bronze Smelting Company, Limited, cancels former quotations of phosphor-bronze in the form of rolls, sheets, wire-drawn strips, circles, flat and square wire rods, sheets and screws.

COMPRESSED AIR FOR STREET CARS.—A little eight-page pamphlet containing statements of the adaptability, operation and cost of air power for street cars. It is prepared by the American Air Power Company, 160 Broadway, New York.

THE SMITH TRIPLE EXPANSION EXHAUST-PIPE FOR LOCOMOTIVES is described and illustrated in a little pamphlet which has been received from the General Agency Company, 168 Broadway, New York. The form and claims made for the pipe are set forth, and a convenient table is presented from which the number of revolutions per minute of any driving wheel of ordinary size may be taken at speeds between 5 and 75 miles per hour. The company also has offices in London and Chicago.

The Breaking of Staybolts.

The most marked change of the past few years in locomotives has been in the use of larger boilers and higher steam pressures. This applies to both simple and compound types, and the advantages of high pressures are likely to cause a further extension of their employment. A great difficulty introduced by these changes is an increasing amount of trouble from broken staybolts, which is now a source of anxiety to many mechanical officers and especially to those who have recently felt a sort of helplessness occasioned by the explosion of boilers which were frequently and regularly inspected and were supposed to be made of the best materials. The trouble is not confined to any particular type of boiler; crownbar, Belpaire and radial stayed boilers all show it, and he who will present a remedy will do a service that will be appreciated. The following paragraphs are presented with a view of summing up the evidence in the case in the hope that they may lead to a helpful discussion of the question:

Tests of all of the bolts in fireboxes are required regularly, and in some cases fortnightly, by motive power superintendents, and if these always exposed the bolts which are broken there would be no cause for anxiety, but, as shown by Mr. T. A. Lawes at the recent convention of the Master Mechanics' Association, in remarks printed elsewhere in this issue, it is the partially broken bolts that cause the greatest danger. Mr. Lawes shows that in 13 engines the proportion of bolts partially broken to those wholly broken was as 619 to 440, and he clearly outlines the necessity for precautions with regard to the discovery of the partial fractures, stating that: "A great risk is run by either not drilling the ends or using hollow staybolts and either of these precautions will prevent many boiler explosions with the usual verdict, 'Cause of explosion unknown.'" His remarks are well worth reading and they have been endorsed by a number of men in similar positions. The following extract from a letter from a very prominent mechanical officer is apropos:

The subject of broken staybolts is something that superintendents of motive power of this country cannot give their attention to too quickly. In these days of high pressure and severe engine service strict attention should be paid to proper inspection of staybolts. Our practice has been to examine our staybolts by hammer test every 30 days. About two years ago we adopted the practice of drilling our staybolts in one inch from the outside sheet. It then occurred to us that it would be an excellent thing to test our engines with the hammer test, and after the test was made to drill the bolts. We had the test made at once; it was very rigid and was made by various men, and when the inspector had declared that he had discovered all defective staybolts in the boiler we drilled the ends of the staybolts and then put on steam pressure and found as many as 58 bolts partly broken; none, however, that were completely broken, but the cracks in the bolts would be anywhere from a full half diameter to only only one-sixteenth holding together. This experience proved conclusively that there is only one way to be absolutely sure, and also proved that the hammer test, no matter how carefully or by whom made, would never indicate the bolts partly broken off, which to my mind are quite as dangerous, if not more so, than the bolts broken entirely off, because the latter we can discover by hammer test, while of the former we might have 20 or more grouped together and by giving way suddenly the others in the group would all go at once, perhaps resulting in an explosion or at least seriously bulging the sheet. Mr. Lawes, of the C. & E. I. R. R., in his remarks at the Master Mechanics' Convention, at Old Point Comfort, expressed our experience exactly.

In the hammer test a bolt that is broken entirely across may be expected to reveal its presence, but since every row of bolts has a different sound from every other row and every bolt has a difrerent sound from every other on account of its location in the row, it is not strange that a partially broken staybolt should escape notice. There is less danger of missing them when the boiler is empty of water and when under a slight pressure. Diagrams are now in common use for recording the inspections and reporting the condition of boilers to the officers regularly. These diagrams often show interesting facts with reference to the location of the broken bolts. From a large number of records it appears that in long fireboxes on those of the Belpaire pattern, the greatest number of broken staybolts are found in the first two or three rows at the front and back ends of the box. Where there is a sharp compound curve in the side sheets the majority of broken stays occur in these bends and usually pretty evenly distributed along the whole length of the firebox. With crownbar boilers there seems to be less uniformity of breaking. The cost of renewals is not unimportant, but this side of the question is not the gravest one. If 20 are renewed per locomotive per year on one of the largest Western roads the number for all the engines for a year reaches 17,200, and for another large system the total number per year at the same rate per engine would reach 56,240, which shows that it is well to reduce the number of broken staybolts, entirely aside from the question of safety of boilers.

THE CAUSES OF BREAKAGE.

Staybolts break as a rule at or near the outer sheet. The explanation appears to be that of fatigue and repeated stress of the bolts due to the expansion and contraction of the inner firebox. Pressure has probably but little to do with it, since a ⅞-inch bolt supporting 20 square inches of sheet under 180 pounds' pressure per square inch has a factor of safety of 5. The stress due to steam pressure undoubtedly helps in the destruction, but is not one of the primary causes. Where the firebox sheets crack, the bolts do not seem to break and where bolts break, the sheets do not seem, as a rule, to crack, indicating that one or the other must yield to the expansion and contraction stresses. A difference of temperature of 200 degrees between firebox and shell sheets is reported to have been observed by Mr. A. J. Durston, Chief Engineer of the British Navy, and this authority also found a difference of nearly 350 degrees between the hot side of a ½-inch firebox sheet and the water on the other side of it when the sheet was incrusted with scale $\frac{1}{16}$ inch thick. This brings the temperature up to blue heat, which is a dangerous condition for wrought iron and steel, and probably hastens the destruction. The trouble caused by expansion and contraction is reduced by keeping engines constantly in service, which constitutes an argument favoring long locomotive runs; irregular service, however, such as working heavy grades, gives bad results due to the alteration of great and moderate heat in the firebox. Great strains occur during the kindling of fires, which become reduced as soon as uniform conditions prevail. The reasons for the breaking along the reverse curves in radial stayed boilers appear to be that the mud ring prevents motion at the bottom of the firebox, the tube sheet and crown staying stiffen the top portions and the location of least resistance is along the curves. This explanation would appear to be borne out by the frequent reports of cracked sheets near the mud ring. Here the stays are reinforced by the mud ring, and the yielding, such as there is, must come in the sheets. Where the sheets bend, however, the conditions are reversed and the bolts break.

One experimenter has said: "The difference of temperature between the outside and firebox sheets causes a difference in the amount of expansion, which by constant repetition wiggles the bolt in two." It is doubtless true that the cold air admitted to the firebox while firing has an important effect in connection with this wiggling.

In an elaborate series of tests carried out in 1892 on the Western Railway of France (See *American Engineer and Railroad Journal* 1894, p. 114), which included the measurement of the relative expansion of the firebox and shell of a locomotive boiler, it was discovered, that upon firing up a cold boiler the firebox expanded rapidly at first and five minutes after lighting the fire the expansion had amounted to 0.01 inch. The variations of the shell were very much slower and were not appreciable until 20 minutes after the fire was lighted. The movements of the firebox when the boiler pressure reached 156 pounds amounted to 0.19 inch. This looks bad for the staybolts, but the outside sheets expand when the water becomes hot, and at steam pressures above 128 pounds the expansion of the shell was the same in amount as that of the box. It is at the lower pressure and particularly before the water becomes heated that the severe staybolt stresses occur, and before the boiling point is reached there is a period in which the expansion of the firebox is five times that of the shell.

In these tests the maximum difference in the expansion was found when the boiler was under about 15 pounds' pressure. It then amounted to 0.1 inch and when the pressure rose the shell gradually expanded to match the movement of the firebox. It is well to observe that these tests were made upon a boiler much smaller than are commonly used in this country at the present time.

The number of repeated bendings of about one-eighth inch that staybolt material will stand varies from 1,400 to 93,600, and it is made plain by the tests which have been carried out that the method of making and fastening the bolts in the sheets has an important effect upon their life. It is hard for some to see how the repetition of bending should occur often enough in a locomotive firebox to fatigue the bolts. It is probable that the vibrations due to the roughness of riding has some influence, but the

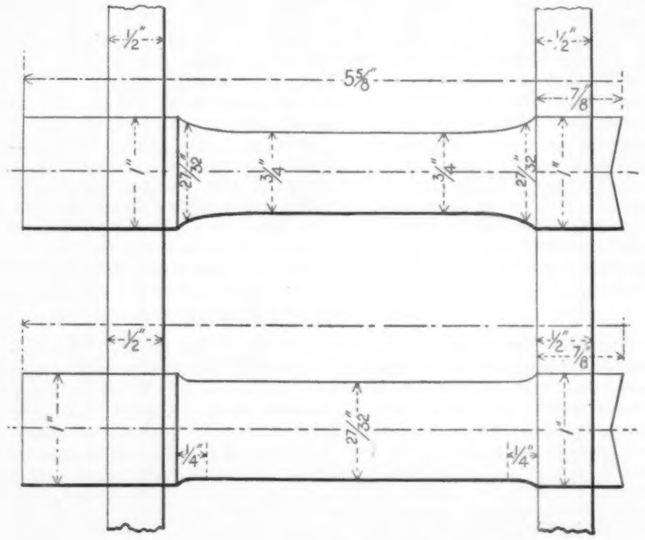


Fig. 1.

worst are those occasioned by the expansion and contraction of the firebox. If an engine is laid up twice a day long enough to allow the steam to run down, and this is repeated for 300 days each year, the bolts will receive at least 600 bends, and if an average of 2,400 bends is allowed for a bolt its life would be about four years. In actual practice with pressures of 190 and even 200 pounds, and with as much as three tons of coal burned per hour in a firebox, it is little wonder that the combination including "blue heat" should bring some of the bolts to end sooner than that. More light will probably be thrown upon the effect of vibrations on staybolts when the results of some experiments now in process are published. It is safe to say that the failures are due to repeated straining beyond the elastic limit by difference in amount of expansion and contraction of parts of the firebox. The stresses produced by these causes are enormous. Experiments made in England with fireboxes slightly corrugated, and somewhat more easily compressed than straight ones would be are said to have shown that 600 tons pressure was required to shorten a firebox 2 feet 6 inches diameter by $\frac{1}{32}$ inch. As to the matter of blue heat it is well to observe that steel having an elastic limit of 35,000 pounds at zero degrees has its elastic limit reduced to 20,000 pounds at 600 degrees Fahr.

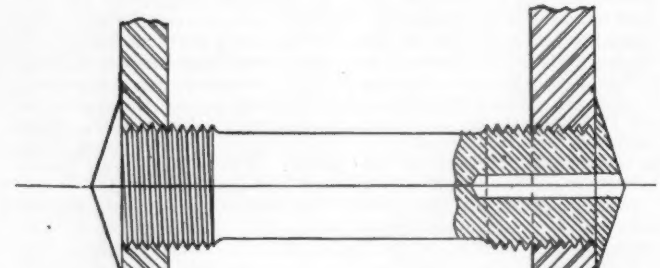


Fig. 2.

POSSIBLE REMEDIES.

A number of suggested remedies will be briefly noted:

The use of sharp dies and loose fits of the bolt-threads in the sheets have been tried with indifferent success. It has been urged that stays should be screwed home with small hand wrenches and the dies should be renewed often enough to make this method possible. Also, that there is no reason why staybolts should fit tight on the bottom of their threads, and that turning off the threads on the taps, so as to get a round thread in the sheets against the bottom of the threads on the bolts, would leave the bolts sufficiently loose to let them wiggle enough to relieve the bolts from bending. No record is known of this having been tried. It has often been noted that loose bolts stand better than tight ones. A sharp V thread is a bad one for this purpose, the Whitworth is better, but a rounding off of the tops of the threads in the sheets is probably the best form of threads to be used. This tends to prevent the bending of the bolt across the sharp edge of the sheets and prevents any "jam" in the action of the thread in the sheet. The trouble with loose bolts, however, is that they do not stay loose, but corrosion cements them fast after a short time.

The sheets of fireboxes have been thickened and the staybolts have been somewhat shortened with the increase of steam pressures and this results in the sheets being stiffer than the bolts and the bolts yield first. It is urged that if staybolts are increased in diameter and consequently in stiffness a balance might be obtained, but it is questionable whether this could be done, even if they were increased to $1\frac{1}{4}$ inches in diameter. From experimental work it appears that increasing the diameter of the stays increases the bad effect of the vibrations. An increase in the number of stays would appear to be equally futile.

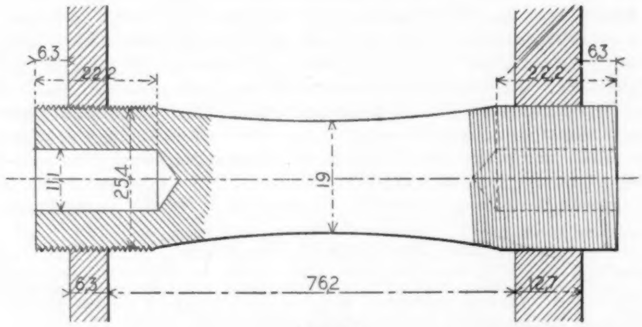


Fig. 3.

More attention has been given to rendering staybolts flexible than to any other remedy and several methods of doing this are illustrated in the accompanying engravings, the object of these being to prevent the localization of the bending by distributing it over the whole length, or by providing a joint at the outer sheet which might yield to side motion. Fig. 1 is a diagram showing a form of stay now being tried in one firebox of the Boston & Albany Railroad, from which good results are expected. The form shown in Fig. 2 is that used by the Baldwin Locomotive Works in all locomotive fireboxes. The form given in Fig. 3 is used on the Great Eastern Railway of England in connection with steel fireboxes and shells. Fig. 4 is a flexible staybolt designed by Mr. Joseph Nixon, foreman of the boiler shops of the Pennsylvania Railroad at Altoona. This illustration is reproduced from the September, 1896, issue of this journal, in which the attachment was described in connection with the Altoona shops. This consists of a nut with a tapered thread $1\frac{5}{8}$ inches in diameter which is screwed into the outside [plate of the firebox. The hole on the

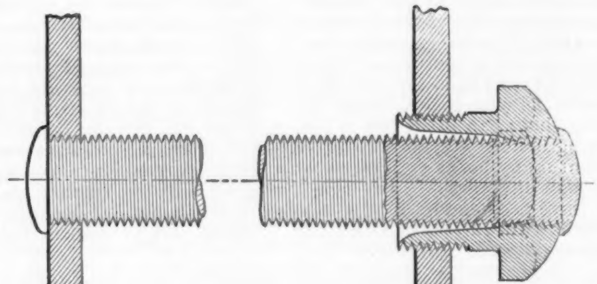


Fig. 4.

inside of the nut is tapered, and "runs off to nothing," in the thread which is cut in the outer end of the hole. The point of flexure is thus distributed over some distance. This plan was first tried in 1892 and is found satisfactory, as was noted in the description referred to. In Fig. 5 an

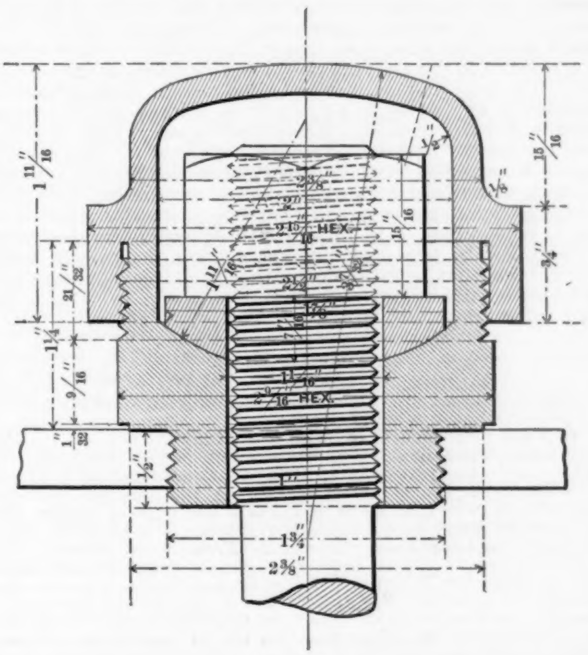


Fig. 5.

expansion staybolt attachment is shown as applied to the Pennsylvania class L engines and was illustrated in this journal, issue of August, 1896. This arrangement is applied to crown stays and it allows them to pass upward through the outside sheet when the inner box expands. The method of preventing the escape of steam is made apparent in the drawing. The Yarrow system is illustrated in Fig. 6. This form was used a number of years ago in some fast passenger engines for the Swedish state railroads. The design is clearly indicated by the engraving. The last two forms are used on crown stays, and only then in the places where the greatest movement occurs. They have been found satisfactory, but the objection of high first cost has been raised against them. The use of longer bolts for staying side sheets has been advocated, but inquiry shows that this is not always successful. It is true that comparatively few crown stays break, but it is difficult to lengthen the side stays to any extent. Somewhat longer bolts might be used at the reverse curves, but the arrangement used on the Pennsylvania appears to provide a better method. Greater water space and straighter side sheets, with fireboxes above the frames, would be an improvement, but it is stated by one who has tried it that merely lengthening the staybolts even to a length of 8 inches will not alone prevent their breaking.

Copper is extensively used for firebox sheets and staybolts in foreign practice with steam pressures as high as 214 and 220 pounds, and there seems to be less trouble there with broken stays. This brings up the question of material. Copper sheets and copper stays yield more readily than steel and iron, and if we cannot use copper with success, nickel steel is worth considering. It has been suggested that nickel steel might be used both for plates and for staybolts. Thinner plates could be employed if of a stronger material than that now used, and their flexibility would probably favor the bolts to some extent, but probably more satisfactory results would follow the experiment of making the staybolts of this material. Nickel steel has been given a cordial reception by engineers because of its toughness, its strength and high elastic limit, its resistance to corrosion, its ability to resist a large number of alternate stresses, and its favorable method of breaking. It does not seem to develop cracks and follow them out to complete fracture, but tears instead. All of these features appear to give this metal interesting qualifications as a staybolt material. The British admiralty have recently brought out some interesting points in favor of nickel steel, but these can only be alluded to here. Landis says: "When the boiler is made entirely of nickel steel, thus preventing electrolytic action, there is no doubt that it is the best material yet applied to that purpose." Its elastic limit is about equal to the tensile strength of ordinary boiler steel, which explains its ability to resist repeated stresses. It is stated that where a low-carbon steel of 0.20 per cent. carbon will stand 300,000 repeated stresses on an alternate

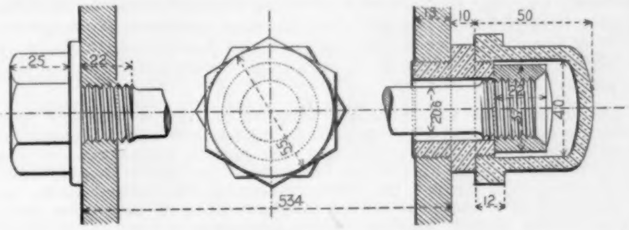


Fig. 6.

stress machine, and a steel of 0.50 per cent. carbon will stand 400,000 repeated stresses, nickel steel will stand from 1,500,000 to 2,000,000 repeated stresses, each of which is about two-thirds of its ultimate strength, or very near its elastic limit.

Thirty-eight years ago Mr. James Milholland appreciated the trouble under consideration and tried a scheme to relieve staybolts by indenting the sheets around them. This, he says, places the iron in such a shape in the sheet as to allow it to spring when the expansion of the sheet and staybolt takes place.

A plan for accomplishing about the same thing has recently been tried on the Chicago, Rock Island & Pacific Railway, and is shown in Figs. 7 and 8. This consists in cupping the side and back firebox sheets at the staybolts after the manner indicated by the sketch. This was first applied by Mr. George F. Wilson, Superintendent of Motive Power of the road mentioned, about two years ago. Of this plan Mr. Wilson says: "I arranged to have half the firebox cupped and half straight or flat in the usual way. The engine was then put in service on a district noted for its bad feed water. It did not take long before the usual trouble with leaking staybolts occurred, but only in half of the firebox, the side with the straight plate. The side where the sheet was cupped

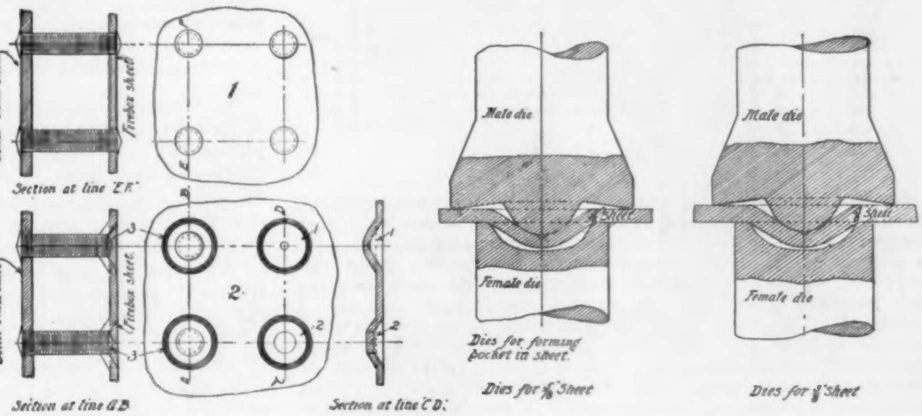


Fig. 7.

did not show a sign of leak or weakness, and, up to date, this side is as tight as when the firebox was new. Encouraged by the good result, I had the firebox sheets in a number of boilers 'cupped,' and in every instance with satisfactory results."

This plan appears to give the desired results. It has been patented in the United States and Canada, and, according to these experiments, it improves fireboxes to an extent that more than pays the cost of cupping. Mr. Wilson believes that if the cupped firebox, properly made, is tried in cases where trouble has been found, the result will convince the most skeptical.

Hollow and drilled staybolts tend to reduce danger from the fact that they reveal the existence of fractures which are sufficiently deep to open into the hole in the bolt. The holes when drilled are usually not more than 1 or 1½ inches deep and the comparative merits of drilled and hollow bolts are very well expressed by a committee of the Southern and Southwestern Railway Club in 1893.

The superiority of the hollow over the drilled stay is due to the fact that the hole runs the entire length through and the flexibility is equal to the entire length whereas drilling a hole at the outer end of the stay, say 1 inch or 1¼ inches in depth, weakens the stay at a point where it has a tendency to break anyway.

The holes when free clear through the stays not only permit of the escape of steam when a bolt breaks, but also keep the temperature down below the blue heat. It has been urged that the holes will fill up and defeat the object of the hollow stays, but this cannot be considered serious. The holes may be easily cleared by air pressure or by running a drill into them. Hollow stays made by drilling a 1/4-inch hole entirely through have been used in France for a number of years on the Paris-Orleans, the Paris, Lyons & Mediterranean, the Eastern and the Northern railways. The practice on the Roumania State Railway has been to drill a 3/16-inch hole and plug it on the inside end of the staybolt. As to wearing qualities the hollow stay seems to stand repeated bending better than the solid one and the following quotation from the report of the committee of the Southern and Southwestern Railway Club previously referred to is a strong recommendation of this type.

The committee also obtained samples of hollow staybolt iron which stood a strain of 49,000 pounds with 45 per cent. elongation and 52 per cent. reduction of area. The 7/8-inch stay made of this iron having 3/16-inch hole rolled throughout its entire length broke at 63,720 1/8-inch strokes, but when the center was turned down to a diameter of 3/4 inch this hollow staybolt made of the same iron, stood 93,600 1/8-inch strokes before breaking—a very remarkable performance. . . .

The committee believes that hollow staybolt iron should be used, that the thread should be the U. S. standard, 12 threads per inch; that the inner ends of the holes should not be opened after the stays are headed up, but that the outer ends of the holes should be kept open; that 7/8-inch stays should be turned down between sheets to a scant 3/4 inch. . . .

An inspection which may be made at any time with steam up, by any inexperienced person which is as definite and positive as is the case where hollow or drilled stays are used is to be preferred to the uncertain methods of sounding now in use. . . .

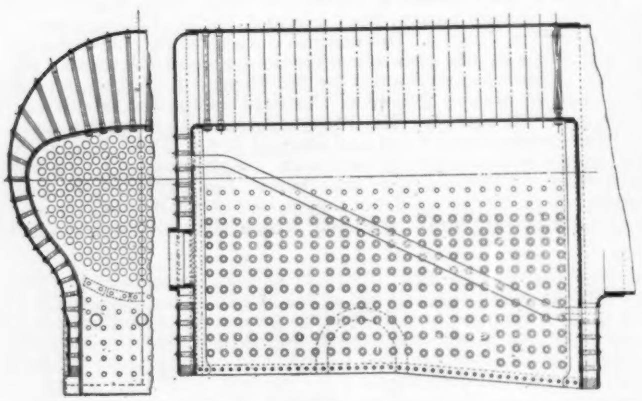


Fig. 8.

Stayless boilers will, of course, do away with broken stays and there are signs of increasing interest in designs which will stay themselves. In marine practice corrugated furnaces are successful to a degree offering considerable encouragement for their employment in locomotives, at least as regards their wearing and resisting qualities. We have in stationary practice a record of a Morison Suspension furnace made by the Continental Iron Works, Brooklyn, N. Y., which worked for 10 years under a pressure of 100 pounds without a dollar's worth of repairs. It was not forced, and even marine boilers are not forced as locomotive boilers are, yet there are good reasons to believe that corrugated furnaces ought to be given an opportunity of showing their adaptability in this work. Mr. G. W. Cushing in a recent communication says: "The discussion of the subject of broken staybolts reminds me of the Strong internally fired corrugated furnace as adapted to the locomotive. This type dispenses altogether with stays and, of course, eliminates all danger from this cause." The sphere and cylinder are the only forms which do not tend to change shape under pressure and cylindrical furnaces are theoretically sound. There may, however, be some difficulty in obtaining sufficient grate area unless the furnaces are double. About eight years ago the Lentz stayless boiler was brought out on the Prussian State Railways. The Strong boiler has been in use for about thirteen years in this country, and this type of firebox appears to deserve further experimental application for large high-pressure locomotive boilers. The brick-lined firebox is thought by some to have strong qualifications, and it is highly probable that the water-tube principle will soon be tried experimentally on locomotives.

One of the prominent Western roads is about to try an old but apparently sensible plan of putting several corrugations of a depth of about 1 1/4 inches into the fireboxes of a number of new engines. The corrugations will be at about 18 inches centers, and the suggestion was taken from an old firebox that had been made with corrugations of a depth about equal to the thickness of the sheet. The engine having this sheet on one side of its firebox came in for repairs, and the wavy sheet was good while the other had to be renewed.

This article is not an attempt to offer an original solution, but rather to sum up the troubles, their causes and possible remedies, with a view of bringing together the various suggestions that have been made. Staybolt breakage is not believed to be unavoidable, and it appears comparatively easy to detect partially broken bolts by the use of hollow ones. From the foregoing it is also apparent that when good material is used in the hollow form the resistance to the destructiveness of vibrations is exceedingly high. It is clear that locomotive boilers should be kept "hot" as continuously as possible, and this will be favored by the present tendency toward increased locomotive mileage, and, finally, it seems advisable that the advantages claimed for stayless fireboxes with regard to freedom from troublesome repairs to sheets and stays, as well as increased freedom of circulation, should be determined before the corrugated furnace is set aside as not applicable to locomotives. The present form of locomotive boiler can not be claimed to be a model of engineering design. It is the result of what may be called compulsion, and it is not unreasonable to believe that improvements may be made in it and that even a radical change in design may be brought about.

A Russian Canal.

Consul Monaghan sends a communication from Chemnitz to the State Department in which he says:

A deep and long canal is to be built by Russia to connect the Baltic with the Black Sea. This stupendous project indicates the giant aims of the great empire. The canal, as projected, is to connect Riga, on the Baltic, with Cherson, on the Dneiper near the Black Sea, is to be 1,000 miles long, 213 23 feet wide at surface, and 115 feet at the base, with a depth of 27.9 feet. It is to carry easily the biggest battleships of the world. From Riga, the canal is to run into the River Dvina, thence by canals from Dvinaburg to Lepel, through the Beresina and Dneiper to Cherson. It is further projected to cover all the river regions with such a network of canals as would aid very materially in developing the whole surrounding country. Ships that went hitherto by way of the Atlantic, Mediterranean Sea, and Marmora Sea, taking more than 12 days, will need now less than six days. Basins are to be built near Pinks and harbors at all important points along the canals.

Traffic is to be carried on day and night at a possible or permitted speed of about seven miles an hour. The cost of the canal is put down at $95,200,000. It is to be ready for traffic in five years. Surely some, if not all, of the dredging and canal machinery of the United States is much more easily handled and better adapted to such work than are those of this Empire. Even here, the vast superiority of our tools is admitted. The only objection made is to their prices. The market in Russia grows more and more interesting. The share we are to have in it will depend upon ourselves.

Electric Car Lighting from the Axle.

The beauty of the incandescent electric light for the illumination of railroad cars has caused a large number of experiments for the purpose of developing a satisfactory equipment of apparatus. Europeans have spent much time in experimenting with storage batteries, and they appear to have been successful in a plan which involves changing the batteries at the end of each run. Special electric plants are used, and the batteries are handled upon trucks for which narrow-gage tracks are laid from the yard to the electric plant. A somewhat similar plan has also been used to a limited extent in this country.

Direct lighting from dynamos in this country has been successful as far as the operation of the light is concerned. Such plants include auxiliary engines placed in baggage cars or in special cars provided for the purpose. The objection to this is the cost of operation, considerable attention being required for such a system. For a long time efforts have been made to utilize the axles of cars for driving dynamos, one of the advantages of a system operated in this way being that power thus obtained would be cheap from the fact that the dynamo would take some of the power now wasted in the stopping of trains, and in suburban work this is a large item. Another advantage is that little attention would be required for such an arrangement. Storage batteries are necessary in this case because of the stopping of the trains, and altogether there have been many mechanical difficulties in the way of success.

The National Electric Car Lighting Company of New York has perfected a system which is now beyond the experimental stage, and has been in successful use long enough to establish confidence in its efficiency and low cost of operation. The originator of the system is Mr. Morris Moskowitz, to whom the design of the dynamo and the regulating devices is due. A car equipped with this system was put into regular service upon the Atchison, Topeka & Sante Fe Railway in October of last year, and it has made a most satisfactory record. The road has contracted for 50 cars to be fitted with the system, and these will soon be running. The only attention given to the lighting equipment is what it receives from the train crew and it has been demonstrated that the cost of operation of the

system has not been more than that of an ordinary outfit of oi lamps. This car has 14 16-candle power lamps, and two of 8 candle power. The company has an option for 150 additional cars after the equipment of the 50 now under contract.

The light is obtained from a dynamo attached to the car truck, and driven by a camel's hair belt from a split pulley on one of the axles. The proper arrangements for accommodating the vertical movement of the axles are provided, and it is found that a belt such as is now used is good for about 40,000 to 50,000 miles of service, and that no trouble is experienced by reason of snow or rain blowing under the car. A special form of belt-joint is used which keeps the joint itself away from the pulleys, and greatly increases the life of the belt. When the car is running in regular service the dynamo and storage battery furnish light sufficient for about 12 hours of lighting per day, and the accumulators will light the car for 12 hours continuously if the car should remain standing. The dynamo may feed the light directly, and send the surplus into the accumulator, but does not begin to generate current until the train has attained a speed of eight miles per hour, and variations in speed do not seem to affect the quality of the light in any way. The regulation is automatic, and the only attention required on the road is to turn the light on or off. The usual method, however, is to feed one-half of the battery from the dynamo while the other half is furnishing light. The arrangement of the controlling devices is so simple that the running directions may be placed on a 2 by 6 inch metallic tablet on the switchboard. The chief features of the system are the dynamo, the battery of accumulators, a switchboard with the automatic regulating devices and the lamp circuit.

The dynamo is encased so as to be dust and moisture proof and it is so placed upon the end piece of the truck frame as to be easily accessible. Oiling devices for carrying a week's supply of lubricant are provided and the dynamo brushes are manufactured specially for this work with a view of giving a service of several months. The dynamo regulates itself and it is wound so that the current is only three volts higher at a speed of 60 miles per hour, than it is at eight miles. A main switch controls all of the circuits of the dynamo and it must be closed to cause the dynamo to generate. It may be opened at any time when the train is standing to stop the generation. Another simple switch controls the main lighting circuit and a 12-point switch controls the whole system. The switchboard also bears electro-magnetic devices, whereby the poles are automatically changed to correspond to the direction in which the car may be moving. Provision is also made for automatically opening the main circuit between the dynamo and storage battery by the difference in voltage between them. A device recently patented has been added to the equipment to regulate the charge and discharge of the battery in such a manner as to prevent them from being either charged or discharged beyond their capacity. This company has contracted with the Electric Storage Battery Company for five years for what batteries it may require in that period.

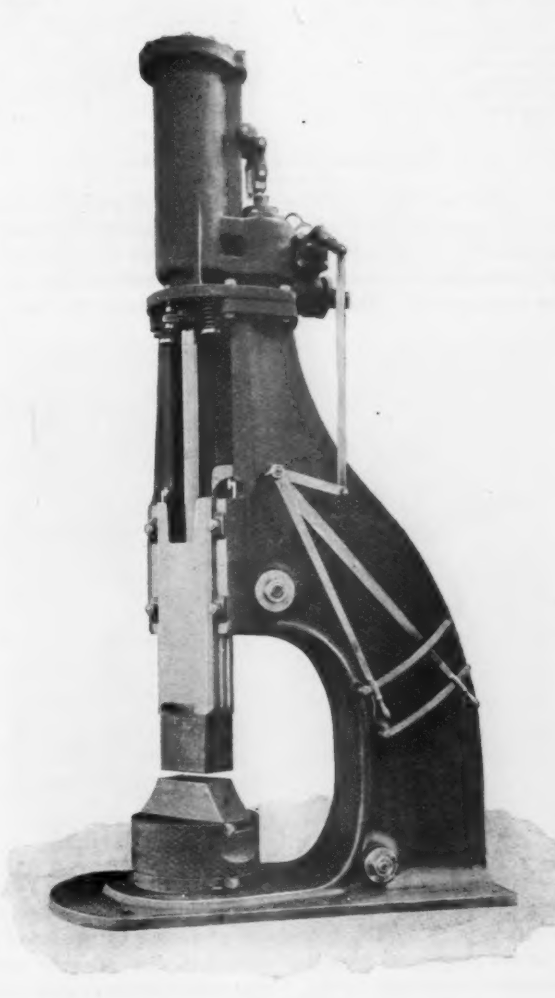
Attention is called to the fact that when the speed of the train is rendered by heavy grades slower than eight miles per hour, the dynamo will take no power for generating, and under ordinary speeds the power required to operate the dynamo is so small that it cannot be measured or noticed in the operation of the train. Another excellent feature of the system is that a single dynamo may be used to light several cars. It is understood that the company is prepared to undertake large installations, and that when applied to sleeping cars the Gibbs patent berth lamp will be used. The chief claims for the system are its reliability and low cost of operation, and while its first cost may seem to be high, the ultimate cost is believed to be favorable to this system above that of oil lighting, and the excellence of the lights is an additional advantage. The President and active officer of the company is Mr. Max E. Schmidt, C. E., who is well known as formerly Chief Engineer of the Mexican Central Railroad and as Chief Assistant Engineer under Captain Eads in the Mississippi jetty work in 1875. Mr. Hiero B. Herr is the General Western Agent of the company, with office in the Monadnock Building, Chicago. The organization is a strong one, having all of the capital necessary for very large contracts.

A New 3,300-Pound Steam Hammer.

The steam hammer shown in the accompanying engraving was built to the special order of Mr. G. W. Stevens, Superintendent of Motive Power of the Lake Shore & Michigan Southern Railway. It was built by Bement, Miles & Company, and the requirements provided that it should be adapted to the various work necessitated in locomotive repairs. It was to have sufficient stroke and weight for expeditious work in welding jaws on locomotive frames and to have sufficient delicacy in operation to permit of its use on light work.

The cylinder is 15 inches in diameter by 42 inches stroke. The distance from the lower die to the lower end of the ram guides is 35 inches, and from the center of the ram to the inside of frame is 39 inches. The ram and guides are set diagonally to the frame at the proper angle for drawing and finishing. The guides are made adjustable so as to provide for taking up the wear of the ram. Elasticity in the frame is obtained by dividing it between the cap and base, and then bolting together with heavy bolts provided with cupped washers. The base of the frame is stiffened by heavy ribs below the floor line.

The valve gear is arranged with the least possible number of moving pieces, and takes up its own lost motion by gravity;



A 3,000-Pound Steam Hammer.

Bement & Miles.

hence it will control the hammer with great uniformity for a much longer time than would otherwise be possible. Having no connection with the ram, it escapes all concussion. It is so designed as to produce, automatically or by hand, every variation in the length, position or force of the blow. The valve itself is of most simple construction, is perfectly balanced, and takes steam both above and below. The piston can be raised above the top of the cylinder for the examination or renewal of packing block rings without disconnecting the rod from the ram. The anvil is made so that the die can be easily removed for repair or replacement without removing the whole anvil.

A copy of a letter to the builders, signed by Mr. Stevens, shows that the requirements have been met admirably.

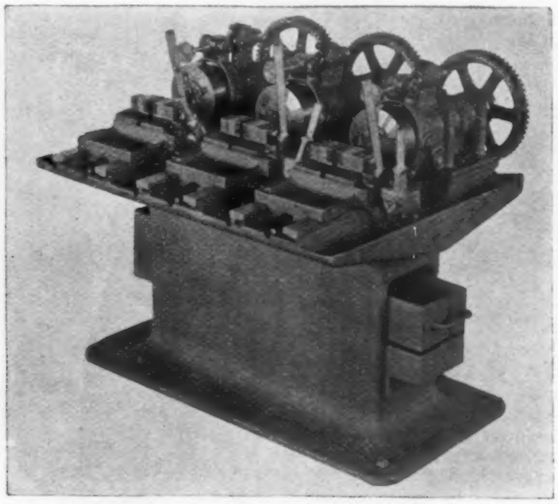
Eight-Wheel Locomotives for the St. Lawrence & Adirondack Railway.

The Brooks Locomotive Works have built three eight-wheel passenger locomotives for the Adirondack & St. Lawrence Railway to be used in the tourist business of that road. The boilers are of the Player patent, Belpaire type. The crank pins are hollow, and the piston rods are extended through the front cylinder heads. Cast steel has been used liberally, and the boiler fronts and smokebox doors are of pressed steel. The general dimensions of the design are as follows:

Weight in working order	122,300 pounds
Cylinders	18 by 26 inches
Driving-wheel centers	Pratt & Letchworth cast steel
Tires	Latrobe open-hearth steel
Engine truck wheels, cast steel, steel tired	28 inches diameter
Outside diameter at smallest ring	60 inches
Working pressure	200 pounds
Boiler covering	Magnesia sectional
Firebox, type	Sloping over frame
Firebox, length	107⅝ inches
Firebox, width	40⅞ inches
Tubes	274, 2 inches diameter
Total heating surface	1814.16 square feet
Grate surface	30.4 square feet
Tender wheels	33 inches diameter, National
Tender frame	Square channel steel
Water capacity	4,200 gallons
Coal capacity	8 tons

The Acme Triple Bolt Cutter.

The engraving illustrates one of two sizes of triple bolt cutting machines, manufactured by the Acme Machinery Company, of Cleveland, O. They have sufficient capacities for cutting bolts from the smallest diameters up to those of one and one and one-half inches respectively. They are specially designed for manufac-



Acme Triple Bolt Cutter.

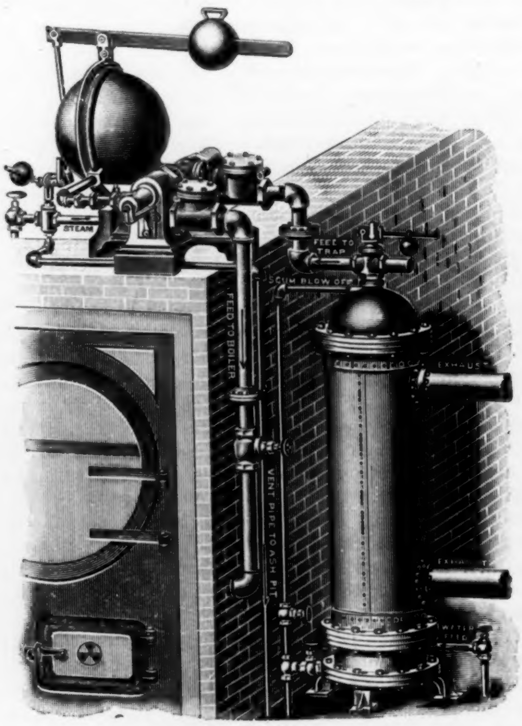
turing purposes where extensive duplication of work is practised The wearing parts of the heads are protected by hardened too. steel for the purpose of resisting wear, and dies of very simple construction are used in them. These manufacturers give special attention to the production of bolt cutters, nut tappers, bolt headers and forging machines. The office of the concern is corner Belden and Hamilton streets, Cleveland, O.

Elevated Railroads and the Brooklyn Bridge.

The contracts between the trustees of the Brooklyn Bridge and the elevated and trolley railroads of Brooklyn have been signed, which means that the elevated railroad trains and trolley cars from Brooklyn will probably be running over the bridge into New York within six months.

The Bundy Gravity Pump.

The Bundy gravity pump is so called because it operates by gravitation and feeds water to a tank or boiler after the manner of a pump. It consists of a gourd-shaped bowl which moves up and down on its fulcrumed axis. The distance traveled is short. its sole function being to open and close a balanced valve, which, when open, allows the pump to discharge and when closed allows it to fill. When the bowl is full of water the weight of the water causes it to settle in the frame and discharge. When empty the bowl is raised in the frame by the ball weight which is placed on the lever at the proper distance to counterbalance and return the empty bowl. This ball may be adjusted to give the desired power and amount of opening to meet any varying condition that may arise. In this arrangement the weight of the bowl and the water in it does not act directly upon the working parts, and since the No. 211 gravity pump bowl holds 60 gallons of water, weighing 500 pounds, the importance of this provision is readily apparent. Underneath the bowl is a stop upon which the bowl rests when discharging. This stop may be adjusted to give more or less motion to the bowl; this, however, is provided chiefly as a matter of convenience, as it has no direct bearing upon the working of the pump. Under the equalization valve is an air valve which is open while the pump is filling and closed while it is dis-



The Bundy Gravity Pump.

charging. It is practically the exhaust outlet, and through it the air escapes from the system when starting up.

During the period of filling the pump is open to the atmosphere through the vent pipe or exhaust, but while discharging it is closed. At each filling and evacuation of the pump a pair of check valves alternately open and close. The check valve in the supply to the pump is open while the pump is filling, the other check valve being closed by boiler pressure. The check valve in the supply to the boiler is open while the pump is discharging, the other check valve being closed by boiler pressure of the water, which has entered the boiler through the equalizing balance valve. The water enters the boiler by gravity, for the pump is placed three feet above the water line of the boiler and has equal pressure with it.

The pump feeds water to boilers from either open or closed feed-water heaters, also returns condensation from all sources. It will pump cold water noiselessly from city supply, tank or pond, the only requisite being to get the water to the pump, which may be by gravity or a pressure of one pound for each two feet of lift. An interior view would disclose no undescribed parts, as the bowl is entirely empty. The balance and check valves are of standard pattern, but made with a view of durability and strength. The full size of opening is maintained from the inlet to the outlet of the pump to insure maximum capacity

In pumping to an elevated tank compressed air may be used

instead of steam, the connection being the same in either case. With 50 pounds pressure of either air or steam water may be raised 140 feet, less the proper allowance for friction. It may be used for pumping water out of cellers or sewers or for filling water tanks on railroads, in which capacity it is claimed to be very efficient.

The A. A. Griffing Iron Company, 66-68 Center street, New York, will furnish any additional information in regard to this apparatus.

Electricity as a Motive Power on Elevated Railroads.

BY S. H. SHORT.

[An elaborate and interesting paper has been received from Mr. S. H. Short, with a large number of illustrations, and we regret that lack of space prevents its publication entire. The text nearly in full and representative diagrams are given below.—EDITOR.]

The elevated railroads of New York, Brooklyn and Chicago were built to satisfy a crying demand for rapid transit from the business centers to the suburban districts of these great cities. So long as they had for their only competitor the slow-moving horse car they were considered a great convenience, notwithstanding that one was obliged to walk from one to three blocks and climb a difficult flight of stairs to reach these rapidly moving trains.

Since the "trolley car" has come into general use people have been educated to a still more rapid rate of travel, and where the trolley car parallels the elevated railroad, as in Brooklyn and Chicago, the frequent, speedy and accessible surface car is by far the more popular. In New York, however, the elevated railroads still enjoy a very large traffic, because the electric cars do not parallel their lines, nor are the facilities for transportation yet sufficient for the enormous masses to be moved back and forth in that city. However, the surface lines are soon to be equipped electrically and their carrying capacity thereby enormously increased, to the detriment of the elevated railroad travel. In order to retain their traffic it will be necessary for the elevated railroads to move their trains more frequently and at a much greater rate of speed to compensate the traveling public for being obliged to walk some distance and climb those disagreeable stairs.

The elevated roads are all built on the same general plan, the structure being provided with double track throughout the entire length, with station about ⅜ mile apart. The grades are slight and the curves of not less than 90 feet radius. The structure is made to safely carry the standard elevated train, i. e., five passenger coaches, each 46 ft. in length, weighing, when loaded with 75 passengers, 20 tons, drawn by a locomotive weighing 23½ tons, making a total of 123½ tons for the complete train.

The locomotives are constructed so that 65 per cent. of their weight, or 15¼ tons, are upon their drivers, giving an adhesion and, therefore, a maximum horizontal effort for accelerating the train of 7,650 pounds. This effort is used for accelerating the train for 50 or 6 seconds and a speed of 20 to 25 miles per hour is attained while a maximum of 300 horse-power is developed by the locomotive. The brakes are then applied with a negative acceleration and the train is brought to a standstill at the next station, where it remains on an average 13 seconds.

In the accompanying diagrams, Figs. 1 and 2, I have illustrated graphically the performance of one of these trains, between stations, also the consumption of power as calculated from the weight and speed of the train. It will be seen therefrom that it is not possible with steam to make a better schedule time than is at present in force, i. e., 13⅛ miles per hour, unless the weight of the locomotive be increased or the trains be lightened. The heavier locomotives would endanger the safety of the entire structure. The lighter loads would necessitate more frequent trains, consequently a much larger force of skilled employees to run the extra locomotives. The cost of fuel for operating a steam locomotive amounts to about 20 per cent. of the total operating expenses of these roads, the fuel consumption being about 7 to 8 lbs. of coal per horse-power per hour.

With good compound condensing engines driving electric generators at a station, the coal consumption is reduced to about one-third of that amount.

Were steam locomotives discarded it would be possible to replace the high priced skilled labor necessary for their operation by ordinary trustworthy men who are not skilled mechanics; whose rate of wages is about one-half that of a locomotive engineer, and only one man would be necessary to operate the electrical propelling mechanism. We believe the repair account will be materially lessened both in the units of motive power and in the permanent way were the trains equipped with motors. The care of a steam locomotive is very onerous, the average run being only about one hundred miles, when it must be thoroughly overhauled and inspected by skilled mechanics before being used again. Contrast with this the all day service of most electric motors two or three hundred miles a day for days and weeks, without inspection, cleaning or care of any kind.

The standard electrical equipment for an elevated train consists of the present elevated car, provided with two swiveled trucks of special construction arranged to receive electric motors of a type adapted especially for this service. The wheels of the trucks are 33 inches in diameter, and the wheel base does not exceed 6 feet for the largest motors, and is reduced to 5 feet 6 inches where motors of the smaller size are used. The weight of the motor car loaded to its full capacity with passengers is 32 tons, including trucks, motors and the electrical equipment. In most cases it is advisable to use only two motors upon a motor car, and both should be placed on one truck for convenience in repairing. There is, therefore, 19½ tons upon the drivers, or 61 per cent. of the total weight of the motor car, which corresponds favorably with the percentage of the total weight of passenger locomotives upon their drivers. This gives an adhesion and, therefore, a maximum practical horizontal effort for the motor car of 9,750 pounds, or a total possible horse-power of 400 in accordance with standard motor rating.

This pair of motors is, therefore, capable of accelerating a train of three standard elevated cars at the rate of 1.85 feet per second, and of making a schedule of 16½ miles per hour, including stops, as illustrated graphically by the accompanying dirgram (Fig. 3).

If the other truck of the motor car is also equipped with motors, a train of double that size will operate in exactly the same manner,

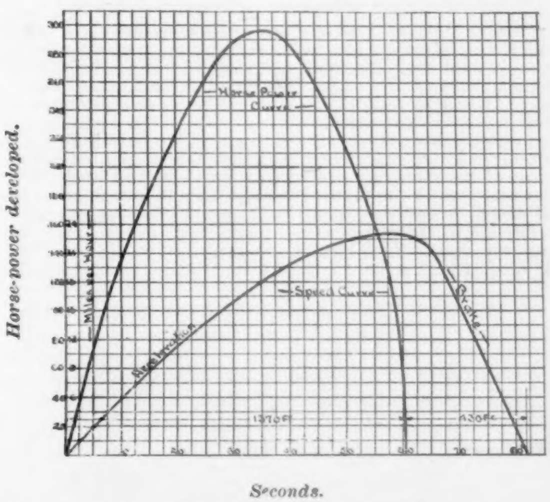


Fig. 1.—Present Manhattan Elevated Train—Ninth Avenue, Sixty-sixth to Fifty-Ninth Street—1,800 Feet.

and one more car may even be added, because the tractive effort required per ton decreases materially as the number of cars in the train increases, there being but one motor car on the train. It is not advisable to use more than two motors, owing to the complications which arise in the controlling devices.

The requirements of the service to be rendered on the different elevated railroads necessitates very careful consideration being given to the size of the motor to be used upon the different roads. There seems to be no question about the advisability of using as large a motor as possible upon a road like the Sixth avenue in New York, where the travel is constant throughout the day, and trains of from four or five cars can follow each other at short intervals all day. But in Brooklyn and Chicago, where the traffic is heavy during short periods of time, and light during a larger part of the day,

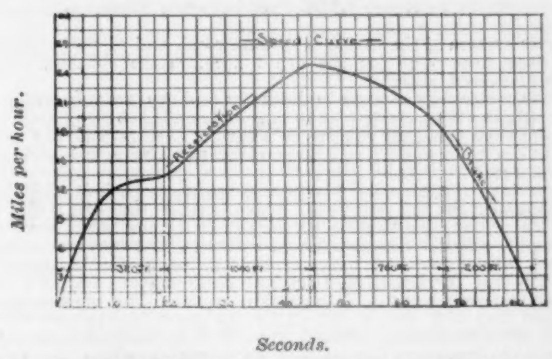


Fig. 2.—Present Manhattan Elevated Train—Ninth Avenue, Twenty-third to Fourteenth Street—2,320 Feet.

it seems desirable that trains of few cars, or even single motor cars, shall be run at frequent intervals without a printed time-table, thereby practically securing a high speed street car service on the elevated structure.

Another reason for frequent and light trains is that these roads have branches, which by this method would be served to better advantage.

It is possible also that these single motor cars or short trains may be coupled into longer trains during the rush periods of the day and be operated from the front platform by one motorman, if a suitable controlling apparatus is provided, by means of which all of the motors of the train can be simultaneously controlled.

A motor of much smaller size than would take up the full adhesive power of the truck could be used where this method of equipment is adopted. It, however, has the disadvantage of multiplying the electrical apparatus necessary to move the rolling stock of the road. It will also consume more power per ton miles of train because the tractive effort per ton of the trail cars is about half that required by the motor cars, the difference being due to the friction, windage, etc., of the motor cars.

For the convenience of engineers making calculations for the re-

quired current in amperes at 500 volts pressure, which will be necessary to operate a given line of road with trains as specified above, we give a table showing the maximum current consumed by trains during acceleration; the current necessary to operate the trains at full speed and the average current and horse-power for the various trains.

CURRENT CONSUMED BY TRAINS OF STANDARD ELEVATED CARS.

Number of cars.	Accelerating current.	Full speed current.	Average current.	Average horse power.
1	200	90	180	131
2	500	175	227	152
3	780	190	348	231

MOTOR BEST SUITED TO ELEVATED SERVICE.

There being neither dust nor water to contend with, the motor can be left entirely open for the free circulation of air over the armature and field magnets, and not only thorough ventilation but 20 per cent. more output can be obtained from a given machine in this way. The open motor can be much more easily inspected and kept free from oil and grease.

This motor is intended to be taken apart by running the truck from under the car, and lifting the upper half of the magnetic ring by means of an overhead crane; this exposes the armature, left with its bearings in the motor frame, which is journaled to the car axle at one side and supported by the truck bolster at the other side. The motor frame has cast integral with it the lower half of the magnetic ring. Each half of the magnetic ring has two pole pieces, wound with a few turns of heavy copper ribbon, so that the

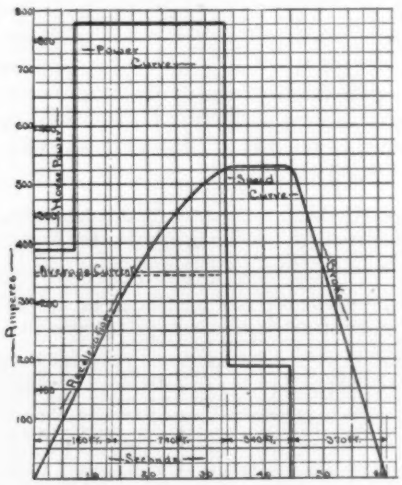


Fig. 3.—74-Ton Train—200 Horse-Power Motors—Schedule 16½ Miles an Hour—1,800 Feet between Stations.

magnetic system of the motor is symmetrical, and of very large sectional area, to provide for the rapid acceleration control, which will be discussed later.

The magnetic ring is large in diameter and the axle is made to pass inside the ring, between the magnetic coils, so that the distance between the gear centers is short. This makes the gears small in diameter and gives a large clearance above the stringers inside the rails.

The armature is especially large and heavy, provided with deep slots to secure the bar winding, which makes but one turn per commutator bar. By this means the self-induction of the armature windings is reduced to a minimum, and there is a very low voltage between the commutator bars, providing for perfectly sparkless commutation. Bronze is used for both the armature and axle bearings, and the lubricant is oil instead of grease. The brasses are so arranged that the thrust caused by the gears brings the shafts against solid, unbroken surfaces. The oil is stored in cellars and is carried to the bearings by means of waste which wipes the entire length of the shafts within the brasses. Provision is made at the ends of the bearings to collect all the oil which may escape and return it to the cellars to prevent a drip on the structure and the street beneath. The bearings are made exceedingly long and the shafts are large in diameter, the pressure per square inch being reduced to the very low value of 37 pounds. The armature bearings are solid and are lifted out of the motor together with their oil cellars when the armature is removed by an overhead crane.

The gear housing is made of heavy cast iron in halves, the lower half being permanently fastened to the motor frame, while the upper half may be lifted off independently by the overhead crane. The housing is grease-tight and the gears run in oil. The entire motor is cast from the best quality of steel.

The motors are controlled by a series parallel controller, which provides for keeping a constant current through each of the motors of such a quantity as will just avoid slipping the wheels during the time of acceleration. We have named this the "maximum constant current acceleration controller." In order to accomplish this kind of a control, the counter electromotive force of the motors is prevented from rising until the train has reached the maximum speed at which it is desired to operate it. The counter e. m. f. is then instantly raised to a point which reduces the current to a quantity which produces a horizontal effort sufficient to overcome the resistance of the train and maintain a constant speed.

The accompanying diagram (Fig. 4) shows the acceleration curve of an ordinary series parallel controller and two series motors; also a curve of the constant current method of control, with two motors of the same size. The advantages of this latter method are apparent in the decrease of the schedule time and the decrease of power consumption.

The Brakes.

Westinghouse air-brakes are used on all trains, with a brake applied to every wheel, enabling a train to be brought to a stop with a negative acceleration of 3 feet per second, which is not disagreeable to passengers.

The train-pipe for this system of brakes is fed with air from a main reservoir attached to one side of the truck bolster of the idle truck of the motor car. On the other side of the truck bolster is attached an electric-motor air-compressor. The motor is arranged to automatically stop and start under the influence of the varying pressure in the main reservoir. The object of putting the air-compressing apparatus on the truck instead of on the car body is to avoid the disagreeable noise due to the operation of the pump and to facilitate repairs, as the truck with its entire air-compressing outfit is run out from under the car in the same manner as the motor truck.

Third Rail Feeder System.

A third rail varying section should be mounted throughout the entire length of the road on substantial insulators. Heavy rails should be laid near the station, and gradually taper off to the end of the road. For most "L" roads, it is not necessary to use auxiliary feeders of any kind as the entire power necessary to operate all trains can be carried by the third rail. This rail should be placed

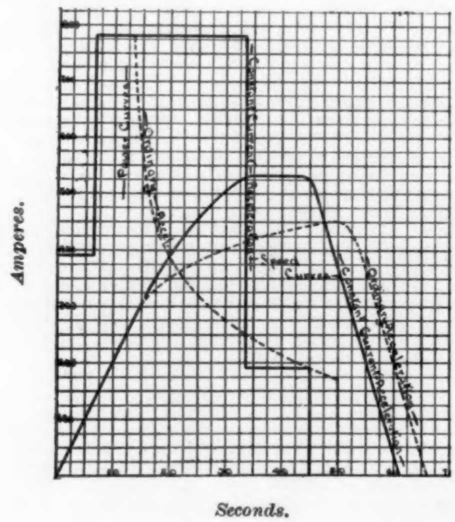


Fig. 4.

on one side of the track with its head some inches above the track rails, so that sliding shoes made of cast iron and attached to the trucks may slide freely along their upper surface.

Bonding.

All rails, as far as practicable, should be in 60 foot lengths. The third rail, as well as the track rail, joints should be bonded by a flexible copper bond attached to the under side or the foot of the rail by means of a number of rivets, and the area of contact with the rail should be sufficient to provide that no more than 100 amperes per square inch should be required to pass through the joint between the steel and copper.

The sectional area of the bond must be one-sixth the sectional area of the rail itself.

The track rails should be electrically connected frequently with the elevated structure.

Care should be taken that all joints between copper and steel should be made with clear, bright surfaces, and no space be left to admit water or air to corrode the joints.

EQUIPMENT AND MANUFACTURING NOTES.

Trojan couplers will be placed on 500 box cars now building for the Canada Atlantic by the Pullman Palace Car Company.

The Elliot Car Company, of Gadsden, Ala., has received an order for 450 box cars from the Louisville & Nashville.

The Michigan-Peninsular Car Company, of Detroit, has secured an order for 50 refrigerator cars for Swift & Company.

National Hollow Breakbeams are used on the three Brooks locomotives for the Adirondack & St. Lawrence Railway.

The Erie has given an order for 500 box cars to the Michigan Peninsular Car Company.

The Mt. Vernon Car Manufacturing Company has taken an order for 250 box cars from the Georgia Railroad Company.

The Ohio Falls Car Manufacturing Company, of Jeffersonville, Ind., has an order for 10 passenger cars for the New York, Ontario & Western.

The Ensign Manufacturing Company, of Huntington, W. Va., has received orders for three Russell snowplows from the Long Island Railroad and for 55 refrigerator cars from the Southern Pacific.

Jackson & Sharp have received an order for 25 passenger cars from the Waterloo underground railroad of London. They will be of the American type.

The Railroad Supply Company, of Chicago, has taken up the manufacture of the Barr vestibule, formerly made by the Drexel Manufacturing Company.

The Ohio Falls Car Manufacturing Company, of Jeffersonville, Ind., has received an order to build 100 flat cars for the Mobile, Jackson & Kansas City Railroad.

The Schoen Pressed Steel Company is doubling the capacity of its plant by the erection of three steel buildings which will be equipped with the most improved machinery, both electric and hydraulic.

A train of the Goodwin Car Company's new steel gravity dumping cars is in daily use handling rock and earth in the work on the Jerome Park reservoir on the New York & Harlem Railroad. The cars may be seen and examined by persons interested.

The Missouri Pacific Railway has given an order for 500 freight cars to the Missouri Car Foundry Company. These builders have also received an order for 200 cars from the Texas & Pacific, and one for 200 from the International and Great Northern.

The St. Louis flush car door will be furnished by the Western Railway Equipment Company of St. Louis, Mo., for the 300 freight cars recently ordered by the Texas & Pacific. These doors will also be applied to 150 cars now building for the International & Great Northern by the Mt. Vernon Car Company.

The Pintsch light has been adopted by the Mobile & Ohio for the illumination of its cars and a gas plant is being erected on railroad property at Mobile, Ala. Pipe lines will be run to the Union Station, and also to the government wharf, in order to supply gas to the Pintsch buoys in Mobile Bay.

The Nassau Electric Railroad, of Brooklyn, N. Y., has contracted with the Standard Railroad Signal Company for three interlocking-plants with a total of 38 levers.

It appears probable that the Hudson River Tunnel scheme will be revived. Mr. C. M. Jacobs is now engaged in working up the financial end of the project in London.

The National Switch and Signal Company, Easton, Pa., has closed a contract for an interlocking plant at Earlville, Ill., at the crossing of the C., B. & Q. and C. & N. W., with 18 working levers and electric locking for the derailing switches.

Detroit lubricators will be used on the two locomotives for the Wiggins Ferry Company, which are being built by the Baldwin Locomotive Works.

The Baldwin Locomotive Works will build 10 compound freight engines for the Canadian Pacific Railway and two six-wheel switching engines for the Wiggins Ferry Company, of St. Louis.

The Leach sander is used on the three locomotives which have been built by the Brooks Locomotive Works for the Adirondack & St. Lawrence Railway.

The Ashton Valve Company is furnishing the safety valves and steam gages for the 10 mogul engines which are being built for the Illinois Central by the Brooks Locomotive Works.

The valves for the ten 19 by 26-inch mogul locomotives now building by the Brooks Locomotive Works for the Illinois Central Railroad, as noted in our issue of last month, are of the American Balance type, and are being furnished by the American Balance Valve Company, of Jersey Shore, Pa.

The Baldwin Locomotive Works will build two passenger and four freight engines of the Vauclain compound type for the Chicago, Milwaukee & St. Paul. The same firm has received an order from the Imperial Government Railways of Japan for 20 mogul locomotives with 48 inch driving wheels and tenders of 2,600 gallons capacity, to haul a load of 336,000 pounds up a grade of 1 in 40, combined with 15 chain curves at a speed of 18 miles per hour. The engines are to have automatic vacuum brakes, copper fireboxes and brass flues.

The New Orleans & Western is stated to be about to build shops and a roundhouse at Port Chalmette, La.

It is announced, though unofficially, that the Philadelphia & Reading Railway Company has purchased the plant of the Whitney Car Wheel Works, Philadelphia, with a view to equipping their entire road with car wheels direct from that plant.

The A. A. Griffing Iron Company, 66 Centre street, New York, is advertising its heaters with large colored posters showing the interior of the Bundy Sectional Tubular Heater. These cannot fail to attract attention to the product of the company.

All the shops of the entire Burlington system began working 10 hours on July 26, and the Atchison, Topeka & Santa Fe is now working 1,525 men 55 hours per week on car repairs to handle the the wheat crop. For the first time in four years full time is being worked at the Iron Mountain Railroad shops at Desota, Mo.

The Long & Alstatter Company, of Hamilton, O., has just finished a large punching and shearing machine for the Missouri Pacific shops at Baring Cross, Ark. The machine is an extra heavy double punch and shear, with 42-inch throats, and is capable of punching a 2-inch hole through 1¼ inches of metal. Its reach is sufficient for a 42-inch sheet.

It is announced that a deal is nearly concluded between the American Air Power Company, of 160 Broadway, New York, the owners of the Hardie system of compressed-air traction, and the Metropolitan Traction Company, of New York, who control the Hoadley patents. Under the terms of the agreement a new company will be organized to control both the Hardie and Hoadley systems, and the Metropolitan Traction Company will at once order about 50 Hardie motors for use on the company's cross-town lines.

General Superintendent Chasseaud, of the American Institute Fair to be held in New York City from Sept. 20 until Nov. 4, is now busily engaged in his office receiving applications for space from intending exhibitors and dealing with the details necessary to the organization of an extensive exposition. Mr. Chasseaud is planning to amplify the departments that have throughout the annual fairs of the American Institute been regular features, and will inaugurate several new departures.

The wisdom displayed by Receiver Oscar G. Murray, of the B. & O., by making a traffic alliance with the Great Northern Steamship Company through Fairport, and the handling of Chicago and Milwaukee freight by way of the Owen Line of steamers, has been demonstrated by material results. Up to July 1 the westbound package freight receipts at Fairport increased about 8,000 tons and eastbound increased about 3,000 tons. The total increase of business was about 25 per cent.

The cities of New York and Boston are trying to keep abreast of the times in the matter of mail transportation and are hurrying forward the completion of the pneumatic tube conduits that form part of the Batcheller rapid postal despatch system, which has been adopted. To operate the system New York is to have two compressors with steam cylinders of 13 inches diameter and air cylinders 26 inches diameter by 20 inches stroke; and one compressor with cylinders 10 inches and 24 inches diameter, respectively steam and air, by 20 inches stroke. Boston is to have two air compressors of the latter size. All five compressors are to be "duplex" and the Rand Drill Company, of 100 Broadway, New York, has the contract for making them.

According to the New York *Sun* President A. J. Moxham of the Johnson Steel Company, who is now in England, has just received orders for 20,000 tons of steel rails for electric roads in Ireland. This is probably the largest order of steel rails for electric railway purposes ever shipped out of this country, and the fact that they are sent to the very doors of England is one of the notable features of the affair. The same journal says that Japan is about to place a contract in America for the rails and material required for the 1,200 miles of railroad which it is to construct in Formosa.

The Pittsburgh *Post* says: "The present Baltimore & Ohio management ought to be proud of the record made at Chicago, where it is openly admitted that the new Royal Blue Line trains are the finest that enter the Grand Central depot. Since the repainting and remodeling of the rolling stock the Baltimore & Ohio has earned quite a reputation for fine looking passenger trains, but when the people at the Grand Central at Chicago openly admit that the Baltimore & Ohio has the finest trains entering the building the managers ought to be elated."

A proposition to fit one of the battleships of the *Idiana* class with pneumatic apparatus for steering, turning the turrets, refrigerating, and other purposes, according to the New York *Sun*, is being considered by the Navy Department. Pneumatic arrangements have been on trial on the monitor *Terror* for some time, and it is clear that if the designs of the machinery are well carried out, the second trial will be as successful as the first, and the pneumatic engineers will doubtless see to it that the opportunity for extending the usefulness of compressed air is not lost.

The Sargent Company, Old Colony Building, Chicago, has recently cast a large portable riveter frame in open-hearth steel at the Chicago works. The weight of the casting is 4,000 pounds and the gap of the riveter is 60 inches. It was made for the Chicago Bridge and Iron Works for the pneumatic machine that is to be used in the construction of the bridges for the track elevation work on the Chicago, Rock Island & Pacific Railway in Chicago, and the gap is sufficient to handle any of the plates used. The casting itself is said to be a remarkably good and perfect one, and this is borne out by an excellent photograph which we have received.

Within a short time the long talked of pneumatic despatch system between the New York and Brooklyn post offices will be an accomplished fact. The tubes for conveying postal matter from one city to the other are now being laid. The line will extend from the New York Post Office up Park Row and over the Brooklyn Bridge to the Brooklyn Post Office. The Ingersoll-Sergeant Drill Company, of New York, is furnishing the air compressors to supply pneumatic power for the purpose, and already has orders for several compressors. They will also supply compressors for the plant being installed in Philadelphia. The Batcheller despatch apparatus is the system employed and it will probably be extended throughout all of the cities named.

The Q & C Company has issued the following circular: "We desire to give notice that the exclusive manufacture and sale of the tie plate known as the C. A. C. plate, which is now made in its improved form, is now in our hands, and all quotations and inquiries should be addressed to us. . . . Our company is recognized as having introduced into successful use the plate well known as the Servis tie plate. We have been strong advocates of the longitudinal form of plate with flanges on the outer edge of plate, and the 12 years' success of same, and the many millions in use, distributed over most of our large railroad lines, are facts which prove the justification of our claims. . . . While we cannot consistently advocate forms of plates which differ from the Servis, still to those who insist upon making personal trial, or who specifically demand plates having upper shoulders and crosscutting flanges on under surface of same, we offer the C. A. C. plate, as now improved, as being the most perfect and effective form of that kind."

The Schenectady Locomotive Works are erecting a new riveting tower in their boiler shop and putting in two new hydraulic riveters of 75 and 100 tons capacity each. One of the riveters has a gap of 17 feet, while the other has a gap of 12 feet. The riveters are being built by R. D. Wood & Company, of Philadelphia. Each of the riveters will be supplied with a 20-ton electric crane, furnished by William Sellers & Company, of Philadelphia, the motions of which, hoisting, racking and traversing, are performed by electric motors, operated by the man standing on the riveter platform and who operates the riveter.

is probable that very few people have any idea of the number of different kinds of merchandise an ocean steamship carries from the United States to foreign ports. A short time ago the Johnson Line steamer *Vedamore* loaded at the Locust Point docks of the B. & O. at Baltimore 66 cars of lumber, 4 of starch, 19 of oil cake, 6 of provisions, 1 of organs, 1 of flour, 22 of tobacco, 2 of wire, 3 of sugar, 13 of fresh meat, 20 of sheep, or 1,699 head; 45 of cattle, or 888 head; 3 of lead, 1 of copper, 4 of merchandise and 161 of grain, making a total of 371 carloads.

Our Directory

OF OFFICIAL CHANGES IN AUGUST.

Chattanooga Southern.—W. S. Hoskins has been appointed General Manager, vice M. F. Bonzano, resigned.

Chicago, Peoria & St. Louis.—Mr. H. T. Porter has been appointed Chief Engineer, and Mr. H. C. Landon has resigned to accept a similar position with the New York & Ottawa, headquarters at Cornwall, Ont.

Chicago, Iowa & Dakota.—Mr. Conrad Miller has been elected President.

Chicago Terminal Transfer Railroad Company. — Mr. S. R. Ainslie has been appointed President and General Manager.

Cleveland, Cincinnati, Chicago & St. Louis.—Mr. Geo. S. McKee has resigned as Master Mechanic to take a similar position on the the Wabash at Moberly, Mo.

Colorado & Northwestern.—Mr. J. T. Blair has been chosen General Manager of this new line, which will start from Boulder, Colo., and run to Salt Lake City.

Columbus, Sandusky & Hocking.—Mr. F. P. Boatman has been appointed Master Mechanic at Columbus. O.

Delaware, Susquehanna & Schuylkill.—Mr. Irving A. Stearns has been elected President.

Dominion Atlantic.—Mr. M. Stewart has been appointed Chief Engineer with headquarters at Kentville, N. S., vice Mr. K. Sutherland, resigned.

Duluth, Missabe & Northern.—Mr. William J. Olcott has been elected Vice-President in place of John T. McBride, resigned.

Fitchburg.—Mr. Henry S. Marcy, President, died Aug. 10, and will be succeeded temporarily by Mr. Robert Codman, a member of the executive committee.

Flint & Pere Marquette.—Mr. John W. Graham, President of the International Trust Company, of Boston, has been elected Vice-President.

Fonda, Johnstown & Gloversville.—Mr. J. Leslie Hees has been chosen President.

Fort Wayne, Terre Haute & Southwestern.—Mr. F. L. Winsor has been appointed Receiver, with office at Geneseo, Ill.

Grand Trunk.—Mr. S. King has been appointed Master Car Builder in charge of shops at London, Ont.

Green Bay & Western.—Mr. J. A. Jordan, Vice-President of this company, has been also appointed General Manager and Purchasing Agent, vice S. W. Champion, resigned.

Illinois Central.—Mr. David Sloan has been appointed Chief Engineer.

Kansas Midland.—Mr. C. A. De Haven has been appointed Master Mechanic at Wichita, Kan.

Lake Shore & Michigan Southern.—Mr. S. R. Callaway, formerly President of the New York, Chicago & St. Louis, has been elected President to succeed the late D. W. Caldwell.

Mexican International.—General Thomas H. Hubbard has been elected President of this company.

Norfolk & Western.—Mr. L. E. Johnson has been appointed General Superintendent, with headquarters at Roanoke, Va. He was formerly Division Superintendent of the Lake Shore & Michigan Southern Railway.

Northern Pacific.—Mr. C. S. Mellen has been elected President. He was formerly Second Vice-President of the New York, New Haven & Hartford.

Northern Ohio.—Mr. David Anderson has been appointed Master Mechanic, with headquarters at Delphos, O.

Omaha, Kansas City & Eastern.—Mr. John M. Savin has been appointed General Manager. This road is the consolidation of the Omaha & St. Louis and the Quincy, Omaha & Kansas City.

San Antonio & Gulf Shore.—Mr. Jesse Frey has been appointed General Manager, vice Mr. Geo. Dullnig, resigned.

Sylvania.—Mr. L. H. Hilton, of Sylvania, Ga., has been elected President.

Sherman, Shreveport & Southern.—Mr. Thomas H. King, Vice-President of this company, was drowned while bathing on June 16. The position of Vice-President will remain vacant for the present.

South Atlantic & Ohio.—Mr. Channing M. Ward has been appointed General Manager.

Southern Pacific.—Col. Chas. F. Crocker, First Vice-President, died at San Mateo, Cal., July 17.

Texas, Sabine Valley & Northwestern.—Mr. G. M. D. Grigsby has been elected President and General Manager.

Vancouver, Klickitat & Yakima.—Mr. Samuel F. Canby, Manager, was drowned July 26.

Wilkes-Barre & Northern.—Mr. David T. Bound has been appointed General Superintendent and Purchasing Agent.

Wiscasset & Quebec.—Mr. A. S. Erskine has been appointed Master Mechanic, with headquarters at Wiscasset, Me.